BALLARD MINE

2018 FIELD INVESTIGATION WORK PLAN

FINAL REVISION 1

Ballard Mine Site

JUNE 2018

Prepared by:

STANTEC

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P4 PRODUCTION, LLC

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LIST OF ACRONYMS

AOC/CO	Administrative Settlement Agreement and Order on Consent/Consent Order
ASA	Agronomic Society of America
ASTM	American Society for Testing and Materials
A/T	Agencies and Tribes
bgs	below ground surface
BLM	Bureau of Land Management
CEC	cation exchange capacity
CME	Central Mine Equipment
COC	chain-of-custody
DO	dissolved oxygen
DOC	dissolved organic carbon
DOT	US Department of Transportation
DQOs	data quality objectives
EDD	electronic data deliverable
ET	evapotranspiration
FTL	field team leader
GPS	global positioning system
HASP	Health and Safety Plan
HSA	hollow stem auger
ICs	institutional controls
ICP	inductively coupled plasma
ICPMS	inductively coupled plasma mass spectrometry
IDWR	Idaho Department of Water Resources
LTM	long-term monitoring
MDD	maximum dry density
MNA	monitored natural attenuation
MS	matrix spike
MSD	matrix spike duplicate
OMC	optimum moisture content
ORP	oxidization-reduction potential
P4	P4 Production, LLC
PM	project manager

LIST OF ACRONYMS (CONTINUED)

PP	Proposed Plan
PPE	personal protective equipment
PRB	permeable reactive barrier
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RA	remedial action
RD	remedial design
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SEP	sequential extraction procedure
SOP	standard operating procedure
TIC	total inorganic carbon
TOC	total organic carbon
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

In 2017, P4 Production, L.L.C. (P4) completed the remedial investigation and feasibility study (RI/FS) for the Ballard Mine (the Site) with the submittal of the Ballard Mine FS. The FS was summarized in two memoranda: the *Ballard Mine Feasibility Study Report Memorandum 1 and 2* (*Ballard FS Memo #1 and #2*; MWH, 2016 and MWH, 2017). P4 also submitted additional evaluation of the proposed groundwater remedy as requested by the Agencies and Tribes (A/Ts) and as documented in the *Ballard Mine Supplemental Technical Memorandum Monitored Natural Attenuation Remedy for Groundwater Final Revision 2* (*Ballard MNA Memo*; Stantec, 2017a).

Following A/T's approval of the Ballard FS in February 2018, the United States Environmental Protection Agency (USEPA) has prepared and issued, for public comment, a draft Proposed Plan (PP) in April 2018 that presents the Selected Remedy for the Site. It is anticipated that a final PP and Record of Decision (ROD) will be issued for the Selected Remedy later in 2018, at which time P4 and the A/Ts will begin to negotiate a consent decree (CD) for the Remedial Design/Remedial Action (RD/RA).

In the interim, P4 is proposing several Site investigations that need to be performed during the 2018 field season to address A/T comments regarding Site and the Selected Remedy data gaps identified primarily during A/T review of the *Ballard MNA Memo*. These 2018 field investigation also will support future remedial efforts as discussed within this work plan. This work plan provides details regarding the investigation objectives and sampling rationale, methods, equipment, and procedures to be used during the investigations in accordance with Section XX of the Administrative Settlement Agreement and Order on Consent/Consent Order (2009 CO/AOC; USEPA, 2009a) with the A/Ts.

1.1 PURPOSE AND OBJECTIVES

This work plan will provide additional data to support the Ballard Site Selected Remedy by further characterizing the: 1) borrow area cover material distribution and properties that will be used for the proposed upland soils/waste rock remedy; 2) plume stability and attenuation processes of the alluvial and Wells Formation aquifers to support the MNA groundwater remedy component and also to aid long-term monitoring (LTM); and, 3) shallow alluvial aquifer chemical and physical hydrogeologic properties in the vicinity of the proposed permeable reactive barriers (PRBs) and wetland locations that are planned for treatment of mine-affected seeps and springs as part of the alluvial groundwater and surface water remedies. These proposed remedies are further described in *Ballard FS Memo #2*. The purpose and objectives of each of the 2018 investigations are detailed below.

1.1.1 Borrow Area - Cover Material Investigation

The proposed Site remedy for upland soil includes sequential grading, consolidating, and covering the mine-affected upland soil/waste rock to minimize environmental exposures, which would be implemented in conjunction with a phased recovery of incidental phosphate ore. Remedial activities would include moving portions of waste rock dumps to backfill open pits and to create favorable site grades and topography so that stormwater runoff and erosion is controlled, and surface water flows away from the Site through engineered drainages. The resulting graded surfaces would be integrated with the surrounding natural surfaces, and where underlain by waste rock, would be capped with an evapotranspiration (ET) cover system that is designed to shed or otherwise store and evapotranspire water before it infiltrates into and through the underlying waste rock.

Results from two previously completed borrow source investigations in 2014 and 2016 (Stantec, 2017b) indicate the area southwest of the Ballard Mine potentially contains sufficient quantities of alluvial/colluvial material for use in the capping program given the conceptual design of the cover system and the final acreage to be covered. While soil samples were previously collected from several boreholes and test pits and analyzed for geotechnical and agronomic characteristics, more information is required in order to determine the available quantity and suitability of the alluvial/colluvial material in the proposed area. The objectives of the cover material investigation presented in this work plan are to determine:

1) The horizontal and vertical extent of the alluvium/colluvium in the proposed borrow area.

2) The suitability of the alluvial/colluvial material for use as cover material in the proposed ET cover design described in *Ballard FS Memo #2*.

3) If, and what types of, amendments/preparations may be required to add to Site material to make it suitable for the proposed ET cover design described in *Ballard FS Memo #2*.

4) The agronomic properties of the topsoil for use as a growth medium in the cover designs.

In order to fulfill these objectives, additional soil boreholes and test pits will be utilized to collect stratigraphic information of the alluvium/colluvium material, and soil samples will be collected and analyzed in order to determine geotechnical and agronomic properties of potential borrow source material.

1.1.2 Monitored Natural Attenuation Investigation

The proposed Selected Remedy for Site-affected groundwater includes a combination of PRBs, MNA, and institutional controls (ICs), in conjunction with source controls in the upland soil/waste rock. Collection of supplemental data are necessary to further support previous MNA evaluations and to address to address A/T comments regarding Site and the Selected Remedy data gaps identified during A/T review of the *Ballard MNA Memo*.

The USEPA MNA guidance documents are being followed to focus and prioritize collection of these additional data (USEPA, 1999 and 2015). The general objectives of the MNA investigation, as outlined in this work plan, are to: 1) confirm plume stability; and 2) evaluate the mechanism(s) and rate of attenuation processes found at the Site. Elements of the USEPA tiered-approach (Phase I and Phase II) include the following:

- Phase I – Plume Stability Evaluations
  - Groundwater flow direction (calculation of hydraulic gradients); aquifer hydrostratigraphy
  - Contaminant concentrations/distribution in groundwater aquifers by evaluating existing COC trends (i.e., increasing, decreasing, or stable)
  - General groundwater chemistry data
- Phase II – Mechanism and Rate of the attenuation process
  - Detailed characterization of system hydrology (spatial and temporal heterogeneity)
  - Detailed characterization of groundwater chemistry
  - Subsurface mineralogy
  - Contaminant speciation (groundwater and aquifer solids)
  - Evaluate reaction mechanism (site data, laboratory testing, develop chemical reaction model)

For the Phase I elements listed above, the existing data presented in the *MNA Memo* assists with the MNA evaluation, and with the addition of new Site monitoring wells proposed in this work plan, additional confidence will be warranted regarding the groundwater flow direction(s), contaminant concentration, variation, and distribution; and general groundwater chemistry. Phase II elements are an important part of this work plan and these new data, when combined with existing data, will augment and refine the current MNA conceptual model including plume(s) status and stability.

1.1.3 Permeable Reactive Barrier Investigation

As mentioned above, PRBs are a component of the Site groundwater remedy and would be installed in locations upgradient of mine-affected perennial seeps/springs. The purpose of the PRBs is to reduce constituent concentrations in a portion of the alluvial aquifer before it discharges at the seep/spring location where there is potential for direct contact by humans or wildlife. PRBs will be constructed early during the phased upland soil/waste rock remedy construction (currently P4 is envisioning that Phase I will begin on the east side of the Site). PRBs will be used to treat the seeps/springs in the interim until the positive effects of the upland soil/waste rock remediation (i.e., source control/reduced infiltration) are realized. To effectively evaluate the use of PRBs that will be located upgradient of the mine-affected seeps/springs, additional stratigraphic, hydraulic, and geochemical characterization of the alluvial aquifer is necessary in the immediate area of the proposed PRBs.

1.2 SITE PHYSICAL SETTING

Ballard Mine is located approximately 13 miles north-northeast of Soda Springs, Idaho in Caribou County (**Drawing 1-1**) and is accessed via the Blackfoot River Road, off State Highway 34. Ballard Mine was in operation between 1952 and 1969 and is comprised of external mine waste dumps, open pits, an abandoned haul road, and the Ballard Shop Area, all of which cover approximately 534 acres of disturbance. P4 owns approximately 865 acres of surface rights and has a surface easement from the State of Idaho on an additional 360 acres. These properties contain all of Ballard Mine (**Drawing 1-2**). The adjoining properties are all privately held ranching and farming properties. The nearest downstream Federal land is a 40-acre Bureau of Land Management (BLM) parcel approximately one mile southeast of the mine. Additional details describing physical features at the Site geology and hydrogeologic characteristics are contained in the *Ballard Mine RI Report – Final Revision 2* (*Ballard RI Report*; MWH, 2014).

1.3 REPORT ORGANIZATION

The remaining sections of this document include the following:

- Section 2.0 – Discusses the Data Quality Objectives (DQOs)
- Section 3.0 – Discusses the sampling plan and rationale
- Section 4.0 – Presents the field methods and procedures
- Section 5.0 – Presents the sample handling and analysis
- Section 6.0 – Presents the project documentation
- Section 7.0 – Discusses the quality assurance and control requirements
- Section 8.0 – Presents the health and safety requirements
- Section 9.0 – Presents the references

2.0 DATA QUALITY OBJECTIVES

Data Quality Objectives for the 2018 Ballard Site investigations detailed in this work plan are for collection of data to 1) be used in store and release cover evaluations and potential future modeling efforts, 2) further characterize the alluvial and Wells Formation groundwater plumes to support existing MNA evidence and evaluations, address A/T comments on the *Ballard MNA Memo* , and support LTM of the Site, and 3) provide stratigraphic and hydraulic data to support design of the Phase I PRBs.

DQOs for the investigation are developed to facilitate the collection of reliable data for decision-making by the project management team. A systematic seven-step planning approach outlined in the USEPA quality assurance document *Guidance on Systematic Planning Using the Data Quality Objective Process* (USEPA, 2006) is used to establish performance or acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity as provided below:

1) State the problem
2) Identify the goals of the study
3) Identify information inputs
4) Define the boundaries of the study
5) Develop the analytic approach
6) Specify performance or acceptance criteria
7) Develop the plan for obtaining data

Each step of the DQO process defines criteria that will be used to establish the final data collection design. The first five steps are primarily focused on identifying qualitative criteria, such as:

- The nature of the problem that has initiated the study and a conceptual model of the environmental hazard to be investigated.
- The decisions or estimates that need to be made and the order of priority for resolving them.
- The type of data needed.
- An analytic approach or decision rule that defines the logic for how the data will be used to draw conclusions from the study findings (USEPA, 2006).

Step 6 in the DQO process establishes acceptable quantitative criteria on the quality and quantity of the data to be collected, relative to its ultimate use. Step 7 of the DQO process develops a collection design to generate data meeting the quantitative and qualitative criteria specified at the end of Step 6.

The output from step 7 is contained in Sections 3.0, 4.0 and 5.0 and **Appendix A** of this work plan. **Table 2-1** presents information related to the seven DQO steps for each of the predesign investigations.

3.0 SAMPLING PLAN AND RATIONALE

The overall objectives for sample collection varies between the cover material, alluvial/Wells Formation MNA, and PRB investigations as outlined in the DQOs presented in Section 2.0. This section describes the sampling design (i.e., approach and rationale) necessary for collection of these data.

Table 3-1 summarizes the number of samples, location, analytical parameters, and rationale for each investigation location. Section 4.0 as well as **Appendix A** provide details regarding the personnel, equipment, and procedures that will be used in the field to collect these samples and measurements.

3.1 BORROW AREA - COVER MATERIAL INVESTIGATION

Previous investigations of the potential borrow areas within the Site have identified areas that contain alluvium material possibly suitable for use as cover material (Stantec, 2017b). The results of the 2014/2016 investigations indicate that the southwest portion of the Ballard Site is most suitable as a borrow source due to: 1) the location of this area (near to the Site and the covers that will be constructed); 2) the depth of the alluvium (greater than 10 feet); 3) geotechnical and agronomic properties of the soils in this area; and 4) favorable topography for excavating and potentially mixing large quantities of soil.

Additional data in this borrow area are needed to further characterize the vertical and horizontal extent, and geotechnical and agronomical properties of the alluvium for use as cover material. The planned borehole and excavation locations are shown on **Drawing 3-1**. The results of this investigation will be utilized to define the borrow source area and, if required due to material properties, develop soil preparation and amendments so the cover material meets specifications. Please note that in the area south of the Blackfoot River road on **Drawing 3-1** that will be investigated using test pits, the presence or absence of alluvial groundwater into the pits will be noted because groundwater could potentially limit the depth of a useable borrow source in that low-lying area.

A field engineer/ geologist will be on-Site during the drilling of six (6) boreholes and excavation of 14 test pits to log the stratigraphic layers encountered, and to identify suitable locations to collect the samples described below. Three (3) samples from each test pit will be collected for geotechnical testing to characterize the physical properties of the alluvium and the spatial variation of these properties across the proposed borrow area. Two of these samples will be discrete samples collected from distinct layers and one sample will be a composite of all soils across the depth of the test pit. The depths of the test pits are anticipated to be 15 to 20 feet below ground surface (bgs) depending on type of excavator used.

Estimated depths of the soil boreholes are 40 to 150 feet bgs. The borings will be drilled to refusal or groundwater is encountered. One sample will be collected from each of the six (6) soil boreholes and will be a composite of samples collected every five (5) feet within the alluvium.

The proposed geotechnical analytical program is summarized in **Table 3-1**. The soil samples will be subjected to the following geotechnical testing:

- Organic Content – used to determine the moisture content and percent organic matter in soil.
- Atterberg Limits – used to evaluate the shrink-swell potential of the soil and its propensity to develop desiccation cracks during cyclical wetting and drying.
- Unified Soil Classification and Grain Size Distribution Bulk – used to determine particle size distribution and as an indicator of material properties across the entire borrow area. Generally, soils having the same or similar particle size distribution will have similar physical properties.
- Specific Gravity – this test is used to determine the specific gravity of soil solids passing a sieve by means of a water pycnometer.
- Hydrometer Analysis, Double Dispersion and Crumb Test – used to evaluate the erosive potential of the soil due to dispersion.
- Standard Proctor – used to further refine the maximum dry density (MDD) and optimum moisture content (OMC) of the soil for specifying the percent compaction and in-place density of the soil.
- Permeability Falling Head – used to determine the hydraulic conductivity of saturated porous soil material.
- Soil Water Characteristic Testing – 8-point test used to determine the hydrological characteristics of unsaturated soil.

Agronomic properties are those characteristics that affect plant growth and are used to assess whether amendments are necessary to promote plant growth. It is proposed that samples be collected for agronomic properties from the topsoil layer within seven (7) of the test pits. The agronomic properties that could affect plant growth will be evaluated using the following testing:

- Arsenic, cadmium, molybdenum, selenium, and uranium

- Boron (soluble), calcium (soluble), magnesium (soluble), phosphorus, potassium (soluble) and sodium (soluble)
- Cation Exchange Capacity (CEC)
- Conductivity
- pH
- Total Carbon and Total Organic Carbon (TOC)
- Organic Matter and Saturation Percent
- Sulfur
- Nitrate as N (by calculation)
- Nitrate/Nitrite and Nitrite as N
- Nitrogen and Ammonia

3.2 MONITORED NATURAL ATTENUATION INVESTIGATION

The MNA investigation will consist of installation and sampling aquifer solids and groundwater from new monitor wells in the alluvial and Wells Formation aquifers, as well as collection of groundwater samples from existing monitor wells in both aquifers. The drilling program will consist of, the drilling and installation of thirteen (13) new alluvial monitor wells and one (1) soil borehole within and downgradient of the shallow groundwater plumes emanating from both the east and west sides of the Site as shown on **Drawing 3-2**. In the Wells Formation, one (1) new monitor well and one (1) soil boring will be drilled in the interior of the Site as shown on **Drawing 3-3**. The sampling approach for these new monitor wells/boreholes for both aquifers is further described below and details on personnel, equipment and procedures are discussed in Section 4.0.

These new monitoring well locations will be used not only for the MNA investigation but also will be used, along with existing Site wells, for LTM of the Site groundwater plumes.

3.2.1 Alluvial Aquifer Investigation

Alluvial boreholes installed for monitoring wells will be drilled through the alluvium to bedrock or refusal as described in Section 4.0 to depths between approximately 15 and 30 feet bgs as listed in **Table 3-1** and shown on **Drawing 3-2**. During drilling of the boreholes, up to two (2) samples of aquifer solids will be collected from each borehole across key intervals that transmit water (i.e., coarser lenses of sands and gravels below the water table). The aquifer solid samples will be a composite of up to a five-feet interval of material depending on the thickness of the coarser materials logged over the total depth of the borehole. Samples of fine-grained materials (i.e., silts and clays) that do not appear to transmit significant quantities of water will be avoided for aquifer solids sampling.

Aquifer Solids Sampling. Analytical parameters for the aquifer solids sampling vary for each borehole depending on the objectives of the location and as presented in **Table 3-1** (e.g., evaluating aquifer solids in potentially impacted versus unimpacted locations) and will include the following:

- "Total metals", inclusive of metals, metalloids, and non-metals, (aluminum, arsenic, cadmium, iron, manganese, and selenium) – used to determine constituent concentrations in the aquifer matrix.
- CEC – provides indication of sorptive capacity.
- Paste pH – used to evaluate geochemical environment.
- Total inorganic and organic carbon (TIC/TOC) – used along with CEC to estimate sorptive capacity.
- Sequential Extraction Procedure (SEP) – used to obtain assessment of contaminant environmental availability and potential sorptive sites. Provides data on changes in available contaminant mass sorbed to or precipitated in the soil matrix.
- Sorptive Batch Testing – used to obtain assessment of aquifer attenuation capacity. Provides quantitative information on the capacity of the material to attenuate inorganic contaminants.
- Mineralogy – used to identify presence of more or less sorptive minerals; can help estimate attenuation capacity of the aquifer; identification of site-specific metal and mineral associations may be used to evaluate long-term metal retention capacity of the soil.

Groundwater Sampling. Monitoring wells will be installed as listed in **Table 3-1** and shown on **Drawing 3-2**. Following monitor well installation and development, groundwater samples will be collected from the new monitor wells and existing wells (MBW006, MW-15A, MW-16A, MBW130, MBW135) according to the methods and procedures in Section 4.0 and analyzed in the field and in the laboratory for the suite of MNA parameters summarized in **Table 3-1** and listed below:

- Total and dissolved metals (aluminum, arsenic, cadmium, iron, manganese and selenium) – used to define contamination boundaries and plume conditions.
- Major cations (calcium, magnesium, potassium, and sodium) – used in evaluation of geochemical speciation.
- Major anions (alkalinity [bicarbonate, carbonate, and hydroxide], chloride, and sulfate) – used in evaluation of geochemical speciation.
- Conductivity – provides indication of ionic strength and total dissolved solids.
- Dissolved Ferrous Iron (Fe^{2+}) – used to help determine redox conditions.

- DOC/TOC – used to understand attenuation processes and aquifer capacity for contaminant reduction.
- Dissolved Oxygen (DO) – used with ORP to help determine redox conditions.
- Nitrate/Nitrite – used to help determine redox conditions.
- Oxidation Reduction Potential (ORP) – used to indicate oxidizing or reducing conditions.
- pH – important in evaluation sorption capacity of soil.
- Selenium speciation – to evaluate the form of selenium in groundwater (SeIV, SeVI, total dissolved Se, and organic Se).
- Temperature – standard field parameter.
- Turbidity – standard field parameter, used to assess total solids in the sample.

3.2.2 Wells Formation Aquifer Investigation

One monitor well (Wells – A) and one borehole (Wells – B) will be drilled to the upper sandstone units of the Wells Formation. These upper Wells Formation sandstone beds contain most of the bedrock (Wells Formation) groundwater contamination. The strike of the Wells Formation bedding is generally north-northwest in the area of the West Ballard Mine Pit (MMP035), and potentiometric measurements from monitoring wells installed within a single fault block (not separated by faulting) suggest northward groundwater flow, which is consistent with the overall conceptual model of flow northward toward Henry Springs, a regional discharge location. Therefore, the proposed Wells-A location will likely be downgradient of impacted monitoring wells MMW006, MMW020 and MMW021 and will be in a "contiguous" geologic unit.

The proposed monitor well installed under this study is located in a partially backfilled area of the West Ballard Mine Pit (MMP035) as shown on **Drawing 3-3** and is anticipated to be approximately 200 feet deep. Groundwater at this location should be located at a relatively shallow depth in the upper sandstone beds of the Wells Formation, and the location has the further benefit of providing addition hydrogeologic characterization for the West Ballard Pit area when combined with data from MMW006, MMW020, and MMW021. Because of its position in the West Ballard Pit, it may contain elevated concentrations of selenium and other contaminants of concern; however, it is also in a backfilled area and may be an example of contamination attenuation.

The proposed borehole (Wells – B) is in a partially backfilled area of the Central Ballard Mine Pit (MMP036). This borehole location was selected based on review of drilling logs from the 2016 Ballard Exploration program and is anticipated to be 150 feet deep. This location was selected because of the shallow depth and accessibility of the targeted beds in Wells Formation for sample collection. It is not anticipated that groundwater will be encountered in this borehole based on the 2016 drilling results. However, if groundwater is encountered during drilling borehole, then installation of a monitor well will be evaluated.

Aquifer Solids Sampling. Up to three (3) samples of aquifer solids will be collected from each borehole across key intervals that transmit water (i.e., sandstone units within the upper Wells Formation). The aquifer solid samples will be a composite of up to a five-feet interval of material depending on the thickness of the sandstone units logged over the total depth of the borehole. The aquifer solids samples will be analyzed in the laboratory for the parameters listed above for the alluvial aquifer matrix samples.

Groundwater Sampling. Following well installation and development, groundwater samples will be collected from the new well and existing Wells Formation wells (MMW006, MMW020, MMW021, MMW030, and MMW031) according to the methods and procedures in Section 4.0 and analyzed in the field and in the laboratory for the suite of MNA parameters summarized in **Table 3-1**, which is the same list as for the alluvial groundwater samples listed above.

3.3 PERMEABLE REACTIVE BARRIER (PRB) INVESTIGATION

As discussed in Section 1.0, PRBs are a component of the proposed Selected Remedy for Site groundwater and will be installed in the shallow alluvial aquifer above/upgradient of the mine-affected seep/spring locations at the Site in phases. The first phase of remediation will be conducted on the east side (Phase I), followed by the central core (Phase II), and end on the western flank (Phase III) of the Site. The PRB investigations proposed in this work plan are on the east side and correspond to the PRB locations that will be constructed during Phase I of remediation at the Site. Refer to **Drawing 3-4** showing the PRB locations that are proposed for construction during the Site remediation.

PRBs will be installed early in each phase of the RA as an interim measure to treat the seeps/springs until the effectiveness of the upland soil/waste rock remedy is realized. A total of six (6) PRBs are planned on the east side of the Site as shown on **Drawing 3-4**, but only three are proposed for the Phase I investigation. A focused investigation of the shallow alluvium in the vicinity of three (3) seeps/springs (MSG004, MSG005 and MST095) is necessary to support the evaluation of the PRBs (**Drawing 3-5**). These three locations were selected because Phase I of the proposed Site remedial action, which includes re-mining, will occur on the southeast side of the Site near these locations. Data obtained from these first three locations will be used to refine data needs, approaches, and design of the subsequent PRBs. Please note that PRBs depicted on the western flank of the Site (i.e., PRBs -7, -8, and -9) will be investigated and constructed during later phases of Site remediation.

The investigation proposed for each of these three (3) PRB locations (PRBs -1, -2, and -3) will consist of drilling and installation of four (4) piezometers, excavation of two (2) test pits, sampling, and aquifer testing as summarized in **Table 3-1**. Piezometers will be installed upgradient and downgradient of the possible PRB alignment to evaluate PRB performance. Test pits will be excavated along the alignment to further evaluate the hydrostratigraphy and material properties.

Aquifer Solids Sampling. During drilling of the piezometers, up to three (3) samples of aquifer solids according to **Table 3-1** will be collected from among the boreholes across key intervals that transmit water (i.e., coarser lenses of sands and gravels below the water table). The aquifer solid samples will be a composite of up to a five-feet interval of material depending on the thickness of the materials logged over the total depth of the borehole. Samples of fine-grained materials (i.e., silts and clays) that do not appear to transmit significant quantities of water will be avoided for aquifer solids sampling. The aquifer solids samples will be analyzed in the laboratory for the parameters summarized in **Table 3-1** and listed below.

- Total metals (arsenic, cadmium, iron, manganese, and selenium) – used to determine constituent concentrations in the aquifer matrix.
- Anoxic leach test – this test (batch leach test with and without reductant reagent) will be used to simulate aquifer desorption potential under reduced conditions downgradient of the PRB (contaminants sorbed previously under oxic conditions may desorb under reduced conditions downstream of reducing PRBs). Specifically, Step 3 of the Tessier (1979) Sequential Extraction Procedure will be utilized to reductively dissolve iron and manganese oxyhydroxides and hydroxides that may bind COCs in the aquifer matrix. Hydroxylamine hydrochloride-acetic acid is used as the reductant in this procedure.
- SEP test – used to obtain assessment of contaminant environmental availability. Provides data on changes in available contaminant mass sorbed to or precipitated in the soil matrix.

Groundwater Sampling. Following piezometer installation and development, groundwater samples will be collected according to the methods and procedures in Section 4.0 and analyzed in the field and in the laboratory for the PRB parameters summarized in **Table 3-1** and listed below.

- Total and dissolved metals and metalloids (arsenic, cadmium, iron, manganese, and selenium) – can be used to define contamination.

- Major cations (calcium, magnesium, potassium, and sodium) – used in evaluation of geochemical speciation.
- Major anions (alkalinity [bicarbonate, carbonate, and hydroxide], chloride, and sulfate) – used in evaluation of geochemical speciation.
- Conductivity – provides indication of ionic strength and total dissolved solids.
- DO – used with ORP to determine if system is oxic or anoxic.
- ORP – used to indicate whether oxidizing or reducing conditions exist.
- pH – important in evaluation sorption capacity of soil.
- Temperature – standard field parameter.
- Turbidity – standard field parameter, used to assess total solids in the sample.

Following groundwater sampling, aquifer tests (i.e., slug tests) will be performed on at least three (3) of the piezometers to quantify the hydraulic conductivity of the various units and estimate groundwater velocities and fluxes to aid in the PRB evaluations.

4.0 FIELD METHODS AND PROCEDURES

4.1 SITE ACCESS, LOGISTICS, AND SAFETY

P4 will obtain access to the investigation area, if not located on P4 property. The A/T will be notified, at minimum, five business days prior to commencement of field activities. The Stantec Field Team Leader (FTL) will notify the P4 Project Manager (P4 PM, Molly Prickett) at minimum three days prior to working at a mine area. Such notification is necessary to allow time for site-specific safety training by P4, and if necessary, to arrange for a P4 representative to accompany the crew to provide access through locked gates.

Field equipment and samples will be stored at the Fox Hills Machine Shed, owned by P4 (or in another location designated by the P4 PM in the future should a new location be necessary). Equipment, supplies, and samples will be shipped and received from the Monsanto plant, in Soda Springs, in care of the P4 PM. Additional sample handling and shipping information is presented in Section 5.0.

Safety procedures for the site investigation are summarized in Section 9.0 and described in the Health and Safety Plan (HASP) located in **Appendix C**. The mine-specific safety requirements involve a training orientation for hazard recognition and avoidance. If P4's corporate safety policy is stricter than the requirements of the HASP, those corporate safety requirements will take precedence.

4.2 DRILLING

In general, drilling for work activities to be completed will follow those outlined in **Appendix A** SOPs. Stantec and P4 will work with the drilling contractor selected to help ensure that a drilling method will be used that can successfully collect the alluvial and Wells Formation samples. The soil cover, MNA, and PRB boreholes will be collected with 1) a hollow stem auger (HSA) drilling method using a Central Mine Equipment (CME) sampling system or split spoon sampler, or 2) a sonic drilling and coring method. It is probable based on previous drilling at the Site that a method of advancing casing using dual rotary drilling, or the use of dual-tube reverse circulation drill will be needed for the Wells Formation well (both methods are described in the attached SOP in **Appendix A**).

A field engineer/geologist will supervise the drilling operations. The field engineer/geologist will maintain a drill log noting lithology, sampling interval, and other pertinent information. It is anticipated that samples will be collected in the unsaturated and saturated zones from the cuttings and submitted for laboratory analysis at intervals based on the objectives of each investigation and professional judgement. Samples not submitted to the laboratory will be archived. Cuttings will also be collected for lithologic characterization at least every five feet.

4.3 BOREHOLE SOIL SAMPLING

Aquifer material (soil/rock) samples will be collected by an on-Site engineer/geologist from drill cuttings or split-spoon samplers during drilling. Soil or rock samples will be selected from each location based on the sampling approach described in Section 3.0. Samples will be collected with decontaminated stainless steel or disposable samplers. Sample material will be placed in plastic bags. Samples will be labeled with the location ID and name, depth interval, date and time, project information and sampler initials. Sample information will be recorded consistent with the requirements in Sections 5.0 and 6.0. Select samples from locations will be archived for possible future testing.

4.4 WELL INSTALLATION AND DEVELOPMENT

A field engineer/geologist will oversee monitoring well/piezometers installation procedures performed by the drilling company and record the methods and procedures including material types and quantities used to build the well. In general, monitoring wells/piezometers will be installed by lowering schedule 2-inch, schedule 40 PVC casing down the shallow alluvial boreholes to specified depths. Wells completed in the Wells Formation will be constructed of 2-inch, schedule 80 PVC. Screened intervals will be 5 to 15 feet depending on the depth of the hole and the purpose of the monitoring well. The sand pack will be installed downhole until the depth is a total of three to five feet above the top of the screened interval. A bentonite seal will be placed above the sand pack to form a seal extending to the ground surface. The seal will conform to IDAPA 37.03.09, "Well Construction Standards Rules". In general, bentonite chips will be hand poured and the depth will be tagged during placement and verified by volumetric calculations. If artesian conditions result in a water level that is substantially (>50 feet) above the sand pack, the seal will be constructed by placing approximately two feet of bentonite pellets above the sand pack, adding bentonite slurry via a tremie pipe to near the water table, and pouring bentonite chips to the surface. All long-term monitor wells will have surface cement or concrete completions with steel monuments cast into a concrete pad and bollards. All surface casings will be fitted with a locking cap and locked with a P4 Production lock.

Groundwater monitoring wells installed during this investigation will be completed consistent with the Idaho Department of Water Resources (IDWR) regulations and permits obtained for the monitor wells prior to drilling. A more detailed description of proposed drilling and well installation methods is outlined in the **Appendix A**.

Once the wells have been installed, the field engineer/geologist will monitor development performed by a pump crew or the drill rig. The goal of monitoring well development is to remove fines and drilling fluid residue from the gravel pack and the natural formation in the vicinity of the screened interval, which will assure good communication between the aquifer and the well. The result of well development is assurance that a sample collected will be representative of the quality of water moving through the formation.

Development will be accomplished by surging and bailing/pumping and/or air lift. A bailer will be used to clean out any fines that have settled on the bottom of the well. Next, a surge block will be used to agitate the water, causing it to move in and out of the screen. After surging, the bailer will be lowered again to clean out any fines brought into the casing from surging. This cycle will continue until most fines have been evacuated from the well. At this point, a submersible pump will be lowered down the well. Pumping will begin at a low flow rate and will gradually be increased. The discharge flow rate will be increased (if possible) until the well is pumping at its maximum yield without drawdown beneath the pump. Pumping will continue until the water is clear of sediment and field parameters are consistent. A more detailed description of well installation and development is provided in the SOP in **Appendix A**.

4.5 HYDRAULIC CONDUCTIVITY TESTING

Slug testing will be used to evaluate the hydraulic conductivities of the aquifer material for the PRB investigation. It consists of introducing a slug (as instantaneously as practicable) of known volume into the well and measuring the response of the water bearing formation. Either water can be introduced or a solid slug on a rope or cable can be introduced into the well. Pneumatic testing can be considered for deeper wells. With a solid, the response to insertion and withdrawal can be measured. The response will be measured with a pressure transducer inserted within the well. The tests will be completed by a qualified field engineer/geologist. The aquifer testing procedures are further described in the SOP in **Appendix A**.

4.6 GROUNDWATER SAMPLE COLLECTION

Groundwater samples will be collected from screened monitor wells following well development. Samples will be collected using the protocols outlined in SOPs in **Appendix A**. These are the same SOPs referenced for groundwater sample collection in the *Ballard, Henry, and Enoch Valley Mines Sampling and Analysis Plan for Long-Term Monitoring of Surface Water and Groundwater – Final Revision 1* (*2015 LTM SAP*; MWH, 2015). With this method minimal water is produced with the goal of collecting the water within the screened interval of the sampler.

Upon arrival at a monitoring well, static water level will be measured prior to sampling. Measurement of the static water level is performed using an electronic water level indicator. The same measuring point on the well casing is used to ensure the measurements are consistent. The wellhead reference point is on the top of well casing - north side. Refer to the SOP located in **Appendix A** for specific procedures.

In accordance with USEPA protocol, low-stress sampling techniques will be used for sampling wells where possible. The sampling protocol states requirements for water-level stabilization and parameter stabilization. The wells will be purged in accordance with USEPA protocols, such that water from the formation will be transported from the aquifer to the surface with minimal agitation. Groundwater samples will be collected only after water level and parameter stabilization has occurred. In the event that a well produces water at an extremely slow rate and excessive drawdown is occurring during purging (i.e., > 0.30 feet at a low pumping rate of 100 milliliters per minute (mL/min)), then a "purge and sample" method shall be employed. Under these circumstances, the well will be purged dry one time and allowed to recharge to a minimum of 80% of the original water level, and then the sample will be drawn.

Groundwater samples will be field filtered, per the specified method, using a disposable 0.45-micron (µm) filter prior to filling the sample containers. If the samples are collected with a pump, an in-line disposable filter will be placed on the pump discharge line and the groundwater sample will be collected directly into the sample container from the filter discharge. If the samples are collected with a bailer, the sample will first be transferred to a clean container, and then filtered using a peristaltic pump equipped with Teflon tubing and an in-line 0.45 µm disposable filter. The inlet of the pump tubing will be placed in the groundwater sample and the sample will be pumped through the filter and collected into the sample container from the filter discharge. The filters will be discarded after each use.

The following acidified/unacidified and filtered/unfiltered groundwater samples will be collected:

- Filtered, acidified samples will be collected and analyzed for "dissolved" metals.
- Filtered, un-acidified samples will be collected for analytes such as sulfate.
- Unfiltered, acidified samples will be collected and analyzed for total metals.
- Unfiltered, un-acidified samples will be collected.

4.7 FIELD PARAMETER MEASUREMENTS

Groundwater parameter measurements will be made using a flow-through cell, and readings will be recorded after parameter stabilization has occurred. Refer to the groundwater collection SOP in **Appendix A** for stabilization requirements. Field parameter values will be recorded on field data forms and in the field notebooks.

The following field water quality parameters will be measured at all groundwater locations:

- pH
- Conductivity
- DO
- Ferrous Iron
- ORP
- Temperature
- Turbidity

Field meters will be used in accordance with the manufacturer's instructions and calibration performed in accordance with **Table 4-1**. Specific conductivity, dissolved oxygen, turbidity, and pH meter performance will be calibrated, and turbidity meters will be checked each morning prior to field sampling as well as at the end of each day. At the quality assurance/quality control (QA/QC) monitoring stations, all the parameter measurements will be taken three times to confirm consistency in the measurement of these parameters.

4.8 TEST PIT EXCAVATION

Test pit excavation will be performed using standard equipment such as backhoes and will extend to depths of approximately 15 to 20 feet bgs or less. The field engineer/geologist will maintain a log noting lithology, sampling interval, and other pertinent information. Disturbed soil samples will be collected from the excavator bucket or from the spoil pile. To obtain a representative sample of the material at a certain depth, care will be taken not to include scrapings from the sidewalls. Samples will be collected with decontaminated stainless steel or disposable samplers. Sample material will be placed in plastic bags or 5-gallon buckets depending on the volume of material required for investigations. Samples will be labeled with the location identification (ID) and name, depth interval, date and time, project information and sampler initials. Sample information will be recorded consistent with the requirements in Sections 5.0 and 6.0. A more detailed description of excavation methods and procedures is outlined in the **Appendix A**.

4.9 DECONTAMINATION

Equipment used for collecting samples such as split spoon samplers and trowels/scoops will be decontaminated prior to all sample acquisition activities. Sampling equipment will be decontaminated as follows:

- Remove excess rock fragments, soil, sediment, and vegetation
- Wash equipment with Crystal White™ (or equivalent) non-phosphatic, biodegradable soap/deionized water solution
- Rinse with potable water
- Rinse three times with deionized water
- Allow equipment to air dry

All rinsate may be disposed of onsite. Field personnel will handle field equipment and containers carefully to minimize the potential for cross-contamination.

4.10 INVESTIGATION DERIVED-WASTE

Excess soil and rock cuttings will be shallow-spread at each drill site or placed back in the borehole (if possible). Other wastes, such as personal protective equipment (PPE), empty bentonite bags, etc., will be disposed in trash dumpsters designated by P4.

4.11 SURVEYING

Borehole and test pit locations will be surveyed using a hand-held global positioning system (GPS) unit and all monitoring wells will be surveyed using a survey grade GPS. All measurements will be referenced to latitude/longitude WGS84 and State Plane Coordinate System Idaho East, North American Datum 1983, feet. Each test pit location will be marked with a wooden stake, a wooden lath or pin flag and will have the corresponding location ID number written on the marker. During surveying, the northing, easting and elevation will be stored in the GPS unit and downloaded onto a computer and provided to the P4 Project Manager. The handheld and survey grade GPS units will be checked for accuracy following Site procedures including the use of survey control points.

4.12 BOREHOLE/TEST PIT ABANDONMENT

Standard borehole abandonment will be performed, as needed, in accordance with IDAPA 37.03.09 Well Construction Standard Rules. The boreholes must be completely filled with approved seal material, which include using hydrated bentonite in those holes encountering groundwater; otherwise boreholes may be filled using a combination of drill cuttings, bentonite and concrete. Concrete will be used to seal the upper 5 feet of the borehole. Test pits or trenches will be backfilled and compacted and covered with excavated soils immediately upon completion of the test pit.

5.0 SAMPLE HANDLING AND ANALYSIS

This section presents methods for sample handling and analysis based on the sampling objectives outlined in Sections 2.0 and 3.0. Details of the QAPP for the field sampling and laboratory testing program are presented in Section 7.0.

5.1 SOIL AND ROCK SAMPLE ANALYSIS

Soil/rock samples for the various investigations will be analyzed for the analytes listed in Section 3.0 for the soil cover, MNA and PRB investigations. Refer to **Tables 5-1**, **5-2**, and **5-3** for the sample container, required preservation, sample preparation method(s), maximum holding times, methods, and method detection limits for each of the analyses to be performed during the investigations.

5.2 GROUNDWATER SAMPLE ANALYSIS

As discussed in Section 3.0, the new monitoring wells along with existing monitoring wells will be sampled following development for the analytes listed in Section 3.0. Refer to **Tables 5-1** and **5-4** for the sample container, required preservation, sample preparation method(s), maximum holding times, fraction (dissolved or total), methods, and method detection limits for each of the analyses to be performed during the investigations.

5.3 SAMPLING LABELING AND HANDLING

5.3.1 Sample Labeling

All samples will be labeled in a clear, precise way for proper identification in the field and for tracking in the laboratory. The samples will have identifiable and unique numbers. The labels for laboratory analyses may contain the following information, as appropriate:

- Facility name
- Sample number
- Sample matrix
- Sample depth
- Date/Time of collection
- Initials or name of person(s) collecting sampling
- Analytical parameter(s)

- Method of sample preservation

The designations provided for the borehole, test pit, and well locations on **Drawings 3-1** to **3-5** are preliminary and will be labeled according to the designation method outlined below. A coding system will be used to uniquely identify each sample collected. The system will allow for quick data retrieval and tracking to account for all samples. Samples will be numbered sequentially for each borehole and type of sample collected. The sample designation will be recorded on the sample label and logbook. Samples for soil and rock samples will be comprised of the following:

AABBXXaaa-b-c

- **AA** indicates the year (two digits) of the investigation.
- **BB** indicates the month (two digits) of the investigation.
- **XX** denotes the station type; station type which is SC for geotechnical soil cover borehole, MW for monitor well borehole, and TP for test pit.
- **aaa** denotes the specific station number/location.
- **b** denotes the replicate number (blank shall indicate no replicate samples) if there are QA/QC replicate samples, then 1, 2 and 3 represent the replicate samples.
- **c** denotes the sample interval (e.g., 5-10 for a sample collected from 5 to 10 feet).

As an example, sample designation for a soil sample from a soil cover geotechnical borehole collected from a monitor well in July 2018 from the 20-40 feet bgs depth interval would be 1807SC04-20-40.

Groundwater sample identification numbers will be comprised of the following:

AABBGWXYYaaa-b-c

- **AA** indicates the year (two digits) of the investigation.
- **BB** indicates the month (two digits) of the investigation.
- **GW** denotes that groundwater is sampled.
- **X** designates "B" for Ballard and is used to differentiate from other sample stations at other P4 Sites.
- **YY** denotes the station type; station type which is MW for monitoring well.
- **aaa** denotes the specific station number/location.
- **b** denotes the replicate number (blank shall indicate no replicate samples) if there are QA/QC replicate samples, then 1, 2 and 3 represent the replicate samples.

- **c** denotes whether the sample involved special field handling or is to be handled in a specific manner; handling codes are as follows:
  - F: Filtered
  - U: Unfiltered

As an example, sample designation for a groundwater sample collected from a monitor well would be 1807BMW001-F and 1807BMW001-U.

5.3.2 Chain-of-Custody

Each sample will be properly documented to facilitate timely, accurate, and complete analytical analysis. The documentation system is used to identify, track, and monitor each sample from the point of collection through final data reporting. Where practicable, this documentation system may be electronic. Chain-of-custody (COC) protocols will be implemented and followed for samples submitted to off-site laboratories. A sample is considered to be in a person's custody if it is: 1) in a person's physical possession, 2) in view of the person after taking possession, or 3) secured by that person so that no one can tamper with it.

COC forms will be used for sending or shipping samples to off-site laboratory to help ensure that the integrity of samples is maintained. Each form will include the following information:

- Sample number
- Date/Time of collection
- Sample depth
- Testing requirements
- Method of sample preservation
- Number of sample containers
- Recipient laboratories
- Signatures of parties relinquishing and receiving the sample at each transfer point

Whenever a change of custody takes place from the sampler to the laboratory, both parties will sign and date the COC form, with the relinquishing person retaining a copy of the form. For samples shipped by a courier, the laboratory that accepts the samples will inspect the COC form and all accompanying documentation to ensure that the information is complete and accurate before signing the COC form upon receipt of the samples. Any discrepancies will be noted on the COC form.

5.3.3 Packaging and Shipping

After collection, samples will be properly stored to prevent degradation of the integrity of the sample prior to its analysis. As applicable, this includes proper containerization, storing the sample in a refrigerated environment, and analyzing the sample within prescribed holding times. Sampling personnel will inventory the sample containers at the Site prior to shipment to make sure all samples listed on the chain-of-custody form are present.

All samples designated for off-site laboratory analysis will be packaged and either delivered or shipped in accordance with applicable U.S. Department of Transportation (DOT) regulations. Samples will be sealed in the appropriate sampling container. Samples will be containerized depending on media to include laboratory-supplied bottles/jars, plastic bags, or five-gallon buckets, as appropriate.

The originals of the analysis request and chain-of-custody forms will be sealed in a waterproof plastic bag and placed inside the shipping container prior to sealing the container. The shipping containers will be taped shut using strapping tape over the hinges and custody seals placed across the top and sides of the container. Custody seals will be used to preserve the integrity of each shipping container from the time the sample is collected until it is opened by the laboratory. Two or more custody seals will be signed, dated, and placed on the front and back of the sample container prior to transport. Clear tape will be placed over the custody seals to prevent inadvertent damage during shipping. The tape should not allow the seals to be lifted off with the tape and reaffixed without breaking the seal.

Geotechnical samples will be analyzed by IGES of Salt Lake City, Utah. Contact information is:

12429 S 33 E Suite 100
Draper, UT 84020
801-748-4044

ACZ of Steamboat Springs, Colorado will perform the analytical testing. Contact information is:

2773 Downhill Drive
Steamboat Springs, CO 84087
800-334-5493 ext. 101

The laboratory for the XRD mineralogy and anoxic batch leaching analyses is to be determined.

6.0 PROJECT DOCUMENTATION

6.1 FIELD LOGBOOKS

The on-site engineer/geologist will use a weather-resistant, bound, survey-type field logbook with numbered, non-removable pages or hardcopy/electronic field forms to record field activities including geotechnical and geochemical sampling, drilling, etc. The following is an example of the information to be collected on the log sheets or log book:

- Dates and times
- Name and location of the work activities
- Weather conditions
- Personnel, subcontractors and visitors on site
- Sample locations and methods (including sampling equipment), time of sample collection, and sample depths
- Samples submitted to the laboratory for analyses
- Name of carrier transporting the sample (e.g., name of laboratory and shipping carrier)
- Photograph numbers and descriptions (if applicable)
- Description of decontamination activities (if applicable)
- Any deviations from this plan
- Health & Safety meetings including topics discussed and attendees
- Accidents including near misses
- Other relevant observations as the field work progresses
- Problems and corrective actions

At the end of each field day, the project field book will be dated and signed by the field person that recorded notes during the day. If the entire page is not used a line will be drawn through the unused portion of the page. If pages are accidentally skipped, a line will be drawn through the entire page. All corrections will be made by drawing a line through the erroneous information and initialing the change. "White-out" or its equivalent will not be used.

6.2 PHOTO LOGS

Digital photographic records of soil/rock samples, drilling/well installation, and general field activities shall be collected throughout the day to document the day's events and to preserve relevant data. An engineer's scale or tape shall be included in any photographs taken of soil and rock samples.

6.3 REPORTS TO MANAGEMENT

The field team leader (FTL) will summarize the daily sampling activities in a Daily Team Leader Progress Report form. This form requires the input of the following information:

- Date activities occurred
- Identification of the field team leader and all other field sampling personnel
- Identification of subcontractors and visitors
- Summary of the work accomplished
- Identification of work planned or expected but not accomplished
- Description of activities planned for the next day of sampling

The daily progress report form is due to the P4 and Stantec Project Managers at the end of day.

6.4 BOREHOLE LOGS

After collecting the required samples, the field geologist will make a visual description of the lithologic or physical characteristics of the soil samples or rock chips. Lithologic or physical characteristics will include but are not limited to color, grain size (as applicable), plasticity, density, soil moisture, odors, bedding, formation change, and other information needed to accurately describe the borehole lithology. The drill cuttings will be logged for material or rock type and depth (if any), soil/rock classification, and the interface between soil and bedrock, formation changes/contacts, and/or groundwater. As well as providing a visual description of the drill core/cuttings, other information that may be entered on the Borehole Lithology Logs may include:

- Borehole ID number
- A sketch of the borehole location
- Project name and job number
- Date drilled and date completed
- Logged by
- Total depth of the borehole

- Diameter of borehole
- Drilling contractor
- Drilling method
- Borehole abandonment procedure
- Number of blows to drive sampler (if applicable)
- Drill advance rate
- Sampler type (as applicable)
- Amount of material recovered per depth interval

The boreholes will be drilled in accordance with the SOPs in **Appendix A**, respectively.

6.4.1 Soil Classification

Soil will be described in general accordance with the USCS and the American Society for Testing and Materials (ASTM) Standard D 2488 - 90 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure; ASTM, 1990). A detailed description of soil classification that includes the information listed below is described in detail in in **Appendix A**. A detailed description of soils may be difficult when encountering alluvium in the RC holes due to the recovery method.

Field observations of soil classification and other observations will be recorded on field sheets like the Borehole Lithology Logs and Sampling Forms located in **Appendix A**. Information included on the field forms will include the following, as appropriate:

- USCS Group symbol (GW, GP, GM, GC, SW, SP, SM, SC, ML, CL, OL, MH, CH and OH)
- USCS name (silty gravel, silty fine sand, poorly graded sand, etc.)
- Color (Munsell Chart)
- Angularity of coarse-grained soil
- Particle size range and percentage (boulders, cobbles, gravel, sand, fines)
- Plasticity (non-plastic, low, medium, high)
- Density (for clay, silt and sand)
- Moisture content (dry, moist, wet)
- Noticeable odors (if any)
- Structure (stratified, laminated, fissured)
- Hardness of coarse particles

- Cementation (if present)
- Dry strength (none, low, medium, high, very high)
- Dilatancy (none, slow, rapid)
- Minerals (if present)
- Graphic log of bedding, lithological changes, fractures, gouge, organics such as roots and the location of other physical features

6.4.2 Rock Classification

Rock chips will be described in general accordance with the *Classification of Rocks and Descriptions of Physical Properties of Rocks* (U.S Department of Interior Bureau of Reclamation, 2001) (provided in **Appendix A**). Field observations of rock descriptions and physical properties and other observations will be recorded on field sheets similar to the Borehole Lithology Logs (see **Appendix A**). Information included on the field forms will include the following, as appropriate:

- Rock unit/formation name
- Rock type identification
- Weathering
- Color (Munsell Chart)
- Reaction with HCl (none, weak, strong)
- Hardness/strength
- Sedimentary particle size
- Discontinuity
- Structure (e.g., stratified, laminated, fractures)
- Fracture coatings or fillings
- Degree of cementation
- Dry strength (none, low, medium, high, very high)
- Mineralogy (if visible)
- Graphic log of bedding, changes of rock type, fractures, organics such as roots and the location of other physical features

6.5 FIELD CHANGE REQUEST

Due to the conditions associated with field sampling activities, unexpected situations may occur that will require deviations or modifications to the requirements of this work plan. In such situations, the P4 Project Manager may authorize the on-Site geologist or designee to undertake modifications necessary to complete individual tasks. The scope and reasoning behind minor modifications will be discussed in the field report prepared following the 2018 investigation program. Major changes or deviations (e.g., adding or excluding a monitoring location) will be discussed with the USEPA Project Manager prior to initiating field activities.

7.0 QUALITY ASSURANCE AND QUALITY CONTROL

This section presents the QAPP as it pertains to soil/rock and groundwater sample collection, handling and testing of the samples for these 2018 field investigations. The investigation testing refers to the *On-Site and Background Areas Radiological and Soil Investigation Sampling and Analysis Plan – Final Revision 2* (*Radiological and Background SAP*; MWH, 2014b) and the *2015 LTM SAP* and their associated QAPPs for additional details.

7.1 PROJECT TEAM AND ORGANIZATION

The overall organizational structure and key personnel for this investigation and responsibility and authority of each team member is presented below.

7.1.1 A/Ts' Responsibilities

The USEPA administers the RI/FS for the P4 Sites. The USEPA will review and approve this site-specific work plan. The USEPA's Project Manager is Dave Tomten. Communication with the A/Ts will be coordinated by the USEPA Project Manager.

7.1.2 P4 Project Manager

Molly Prickett is the P4/Monsanto Project Manager and is responsible for coordinating the necessary resources at the Ballard Mine to accomplish the investigation elements of the project. Ms. Prickett will be responsible for ensuring that the necessary resources are dedicated to the project and will assure the technical, budget, and schedule requirements are met.

7.1.3 Stantec Project Manager

Chad Tomlinson will serve as the Stantec Project Manager. Mr. Tomlinson will oversee all activities and will assign an FTL and health and safety leader to oversee the field investigations. Mr. Tomlinson will report directly to the P4 Project Manager.

7.1.4 Data Quality Assurance Manager

Linda Goad (Stantec) will be responsible for QA oversight of analytical programs. Ms. Goad will coordinate sample receipt, management, analytical laboratory submittal, and third-party validation. She will also make sure the analytical programs and data quality meet project requirements and is responsible for database management.

7.2 ANALYTICAL METHOD REQUIREMENTS

For each soil/rock and groundwater sample, the contracted laboratory will prepare samples consistent with agreed upon SOPs and the specified analytical method. Specialized testing SOPs are provided in **Appendix B.** Subsamples will be obtained for matrix spikes prior to sample preparation and analysis. **Tables 5-1** to **5-4** summarize the analytes and methods. The investigation testing refers to the *Radiological and Background SAP* and the *2015 LTM SAP* for the complete methods and procedures. For those methods not included in these two documents, the contracted laboratory's calibration and QC procedures will be used.

7.3 QUALITY CONTROL REQUIREMENTS

7.3.1 Field Quality Control Samples

Field duplicates/replicates for each sample matrix will be collected at a rate of ten (10) percent of the number of primary geochemical samples, and matrix spike and matrix spike duplicate pairs will be collected at a rate of five (5) percent of the number of primary samples for geochemical samples.

7.3.1.1 Equipment Rinsate Blanks

Blanks are defined as sample material that is free of reportable concentrations of target analytes; the blanks are introduced at various stages of sample handling to monitor possible contamination introduced by various field activities. Only equipment rinsate blanks from non-dedicated sampling equipment will be used for this project. An equipment rinsate blank is a sample of the deionized water being used by the field team that is collected using decontaminated sampling equipment. The sample is then submitted to the laboratory as a blind sample. Equipment blanks will be collected on a daily basis, and, if more than one team collects samples on a given day, also by each sampling team.

7.3.1.2 Duplicate Sampling

A field duplicate is a subsample that has been divided from the primary sample at some step in the sampling process. The primary and duplicate samples are carried through the remaining steps of the process by the analytical laboratory to evaluate analytical performance. Field duplicate samples provide information on the precision of the sampling, transfer, and analytical process. Field duplicates shall be collected for every 10 field samples for all matrices.

7.3.1.3 Matrix Spike and Matrix Spike Duplicate (MS/MSD) Samples

Site-specific samples need to be used for MS/MSDs. Field sampling personnel will collect extra volume and designate (on the COC forms) the samples that are to be used for the MS/MSD. Every effort will be made to ensure that these samples are representative of the general sample matrix of samples collected on that sampling date. Equipment rinsate blank samples will not be designated for MS/MSDs.

7.3.2 Laboratory Quality Control Samples

Laboratory quality control sample protocols will follow procedures and requirements established in the *2015 LTM SAP* and will include the following, as appropriate:

- Method blanks
- Matrix spikes
- Laboratory control samples (verification solutions)
- Laboratory duplicate samples

7.4 MODIFICATIONS AND DEVIATIONS

Any significant changes to the QAPP will be documented and approved by the P4 Project Manager and USEPA Project Manager. Minor deviations from the QAPP will be documented in field notes and identified in the data summary report.

7.5 DATA VALIDATION AND USABILITY

The following definitions are provided in *Guidance for Quality Assurance Project Plans* (USEPA, 2002):

- Verification – the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual specifications.
- Validation – an analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set.

Based on these definitions, the third-party validator technically will be performing data verification of the sample, calibration, and QC data provided by the laboratory against the criteria specified in the *Radiological and Background SAP* and *2015 LTM QAPP*. Validation will be performed for the standard USEPA methods. The validator will use the *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (USEPA, 2014) as a basis for performing data verification and qualification of data. The validator will document the data verification process on their in-house worksheets and summarize the results in data validation reports.

The validator will use the following data qualifiers ("USEPA Flag"):

U	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximated concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the result may be biased high.
J-	The result is an estimated quantity, but the result may be biased low.
R	The result is unusable. The sample result is rejected due to serious deficiencies in meeting quality control criteria. The analyte may or may not be present in the sample.
UJ	The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

And the following "Reason Codes":

1	Holding Time
2	Sample Preservation (including receipt temperature)
3	Sample Custody
4	Missing Deliverable
5	ICPMS Tune
6	Initial Calibration
7	Initial Calibration Verification
8	Continuing Calibration Verification
9	Low-Level Calibration Check Sample
10	Calibration Blank
11	Laboratory or Preparation Blank
12	ICPMS or ICP Interference Check Standard
13	Laboratory Control Sample or Laboratory Control Sample Duplicate Recovery
14	Laboratory Control Sample Precision
15	Laboratory Duplicate Precision
16	Matrix Spike or Matrix Spike Duplicate Recovery
17	Matrix Spike/Matrix Spike Duplicate Precision
18	ICPMS or ICP Serial Dilution
19	ICPMS Internal Standard

20 Field Replicate Precision

21 Equipment Rinsate Blank

22 Linear Range Exceeded

23 Other reason

24 Result is less than the MDC

25 Result is less than two times the error

The validator will populate an Stantec-supplied electronic data deliverable (EDD) with the following data:

- Field Header "USEPA Flag": Populate with USEPA flags specified above and in template reports.
- Field Header "Reason Code": Populate with all applicable Reason Codes as specified above and in template reports.
- Field Header "Final Result": Populate with the final, qualified result, including any adjustment based on blank contamination.

The validator will perform USEPA Stage 2B verification/validation (USEPA, 2009) on approximately 90 percent of sample data and USEPA Stage 4 verification/validation on the remaining 10 percent of sample data. The Data Quality Assurance Manager will take the lead on validating the verified data.

7.6 AUDITS OF FIELD AND LABORATORY ACTIVITY

7.6.1 Field Audit

The Stantec Project Manager or designee will conduct an onsite system audit of field sampling practices during sampling activities. Any nonconformance observed in the audit will be documented and resolved. The A/Ts may request and/or carry out additional field audits. Any nonconformance with approved sampling requirements that may be observed in the field audit will be promptly evaluated and resolved.

7.6.2 Laboratory Audits

Laboratory performance audit samples will not be prepared for this site characterization. On-site audits of the laboratories are not scheduled to be conducted. The A/Ts may request and/or carry out laboratory audits.

7.6.3 Independent Technical Review

An independent technical review will be performed by the Stantec Project Manager or designee for all draft and final project reports. All comments will be resolved and incorporated prior to final submittals.

7.7 REPORTING

Following completion of these 2018 field investigations, data will be evaluated and reported within a field report for A/T review. The report will summarize the results of the soil cover, MNA, and PRB programs. Information provided in the reports will include summary tables of analytical results, borehole logs, photographic logs, geologic cross-sections, interpretation of data and field observations, estimates of cover material quantities, and further evaluation of the MNA conceptual model. In addition, the report will include quality assurance reporting including any corrective actions, laboratory analysis data, and data validation reports.

8.0 HEALTH AND SAFETY PLAN

Safety procedures for the site investigation are described in **Appendix C** as well as in the Monsanto 6.0 Contractor/Guest Environmental Safety and Health Site Guidelines. The mine-specific safety requirements involve a training orientation for hazard recognition and avoidance and will be provided to each contractor coming on Site.

9.0 REFERENCES

MWH Americas, Inc. (MWH), 2014a. *Ballard Mine Remedial Investigation Report.* Final Revision 2. Prepared for P4 Production LLC. November.

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Stantec, 2017b. *Ballard Mine Remedial Investigation and Feasibility Study Cover Material and Exploration Drilling Report.* Draft. Revision 0. June.

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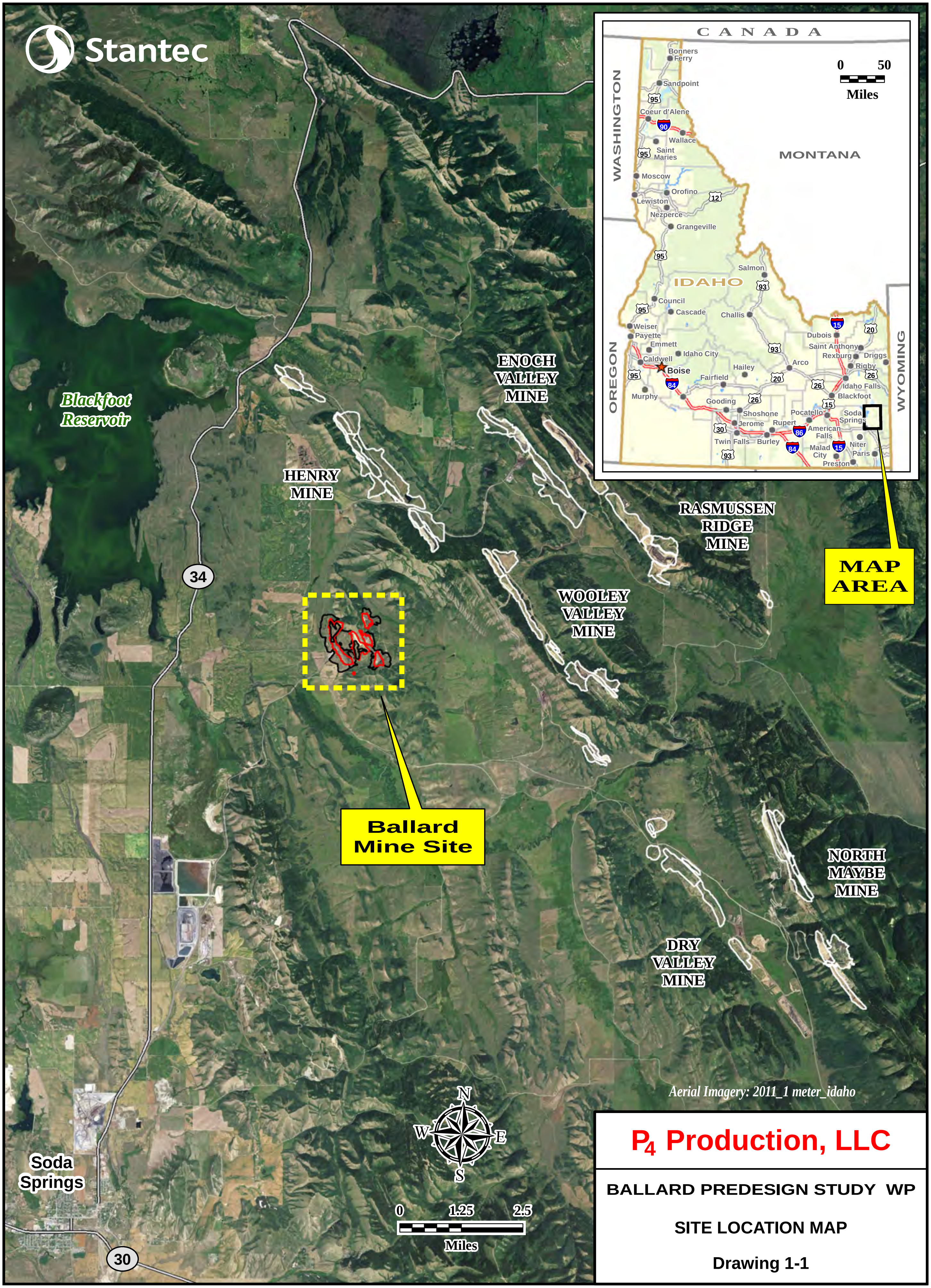
DRAWINGS

DRAWN BY D. Severson

19 Feb 2018

J:\Industrial Projects\P4 Monsanto\P4 Monsanto\Ballard Predesign Study Workplan\FIGURES\Dwg 1-1_Ballard Mine_ Site Location Map_19Feb2018.mxd

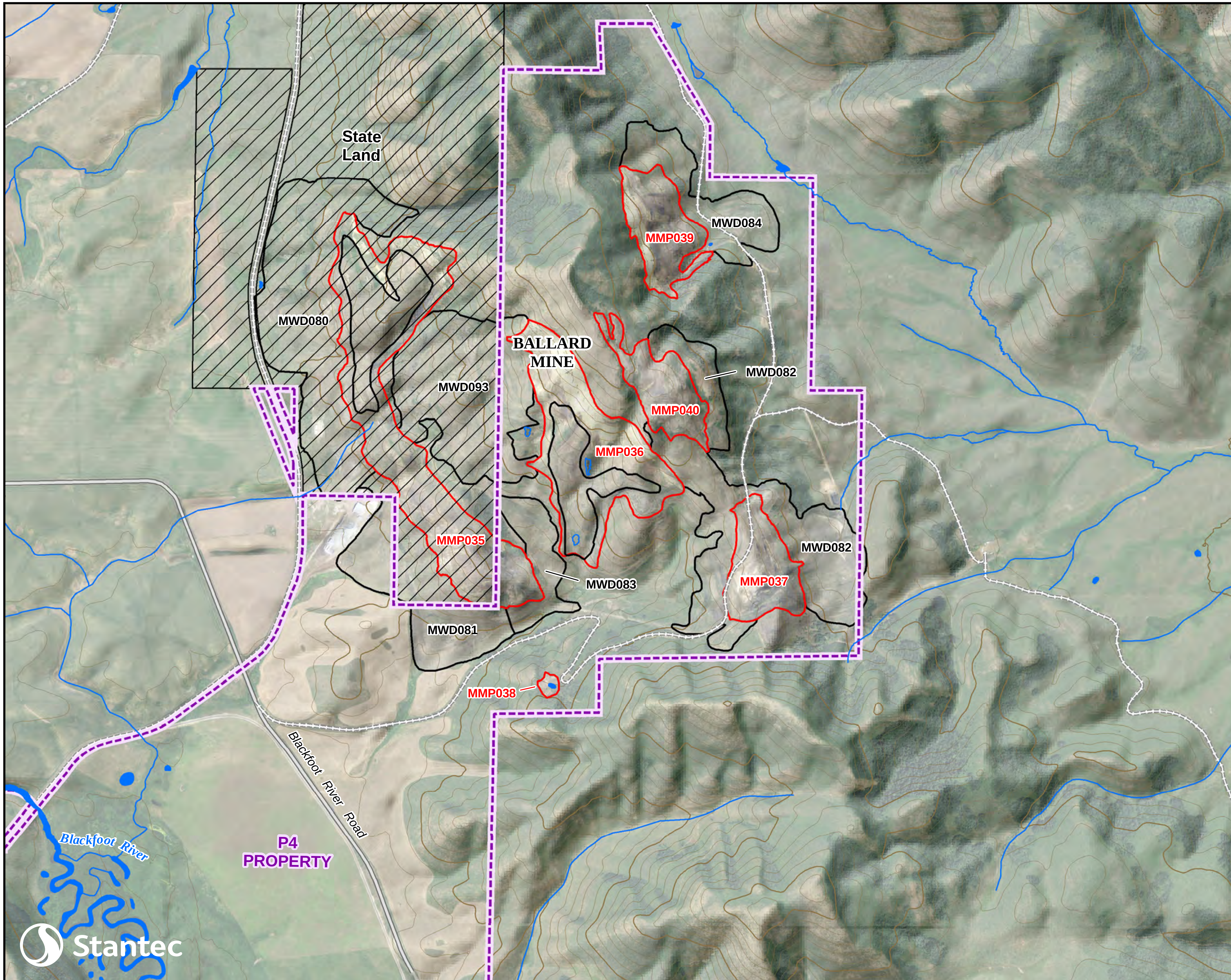


P_4 Production, LLC

BALLARD PREDESIGN STUDY WP

SITE LOCATION MAP

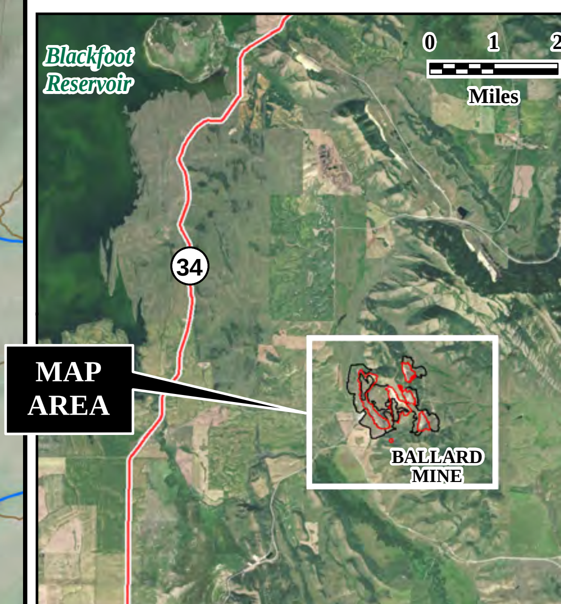
Drawing 1-1



EXPLANATION

Mine pit (approximate)

Waste rock pile (approximate)



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P4 Production, LLC

BALLARD PREDESIGN STUDY WP

SITE LAYOUT

DRAWING 1-2

DRAWN BY D. Severson

7 Mar 2018

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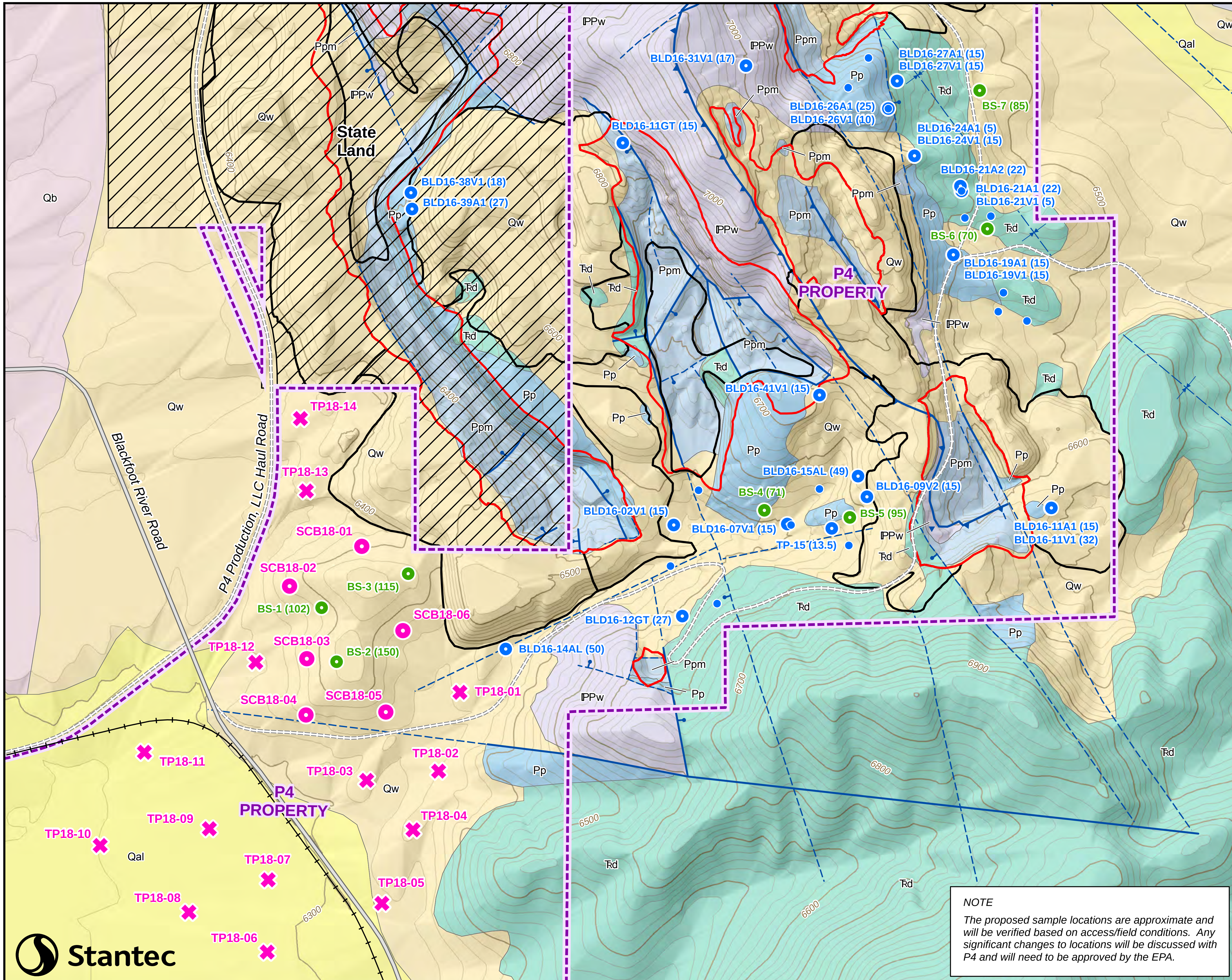
DRAWN BY D. Severson

6 Apr 2018

J:\Industrial Projects\P4 Monsanto\Ballard Predesign Study Workplan\FIGURES\Dwg 3-1 Proposed Soil Cover Characterization Locations_6Apr2018.mxd



EXPLANATION

- 2014 boring (alluvium thickness in feet)
- 2016 boring/test pit (alluvium thickness in feet)
- 2016 boring/test pit (alluvium encountered with thickness of 10 feet or less, NO LABEL)
- Proposed boring
- Proposed test pit
- Qb — Basalt
- Qal — Alluvium
- Qw — Colluvium and older alluvium, may include areas covered in mine waste rock
- Ꞩd — Dinwoody Formation - Woodside Shale
- Pp / Ppm — Phosphoria Formation Meade Peak Member
- PPw — Wells Formation
- Mb — Brazer Limestone
- Fault
- Approximate or inferred fault
- Normal fault (ball on downthrown block)
- Thrust fault
- Axis anticline
- Axis syncline
- Mine pit (approximate)
- Waste rock pile (approximate)

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CONTOUR INTERVAL 20 FEET

GEOLOGIC DATA SOURCES: Hovland, 1981; Mansfield, 1927

NOTE

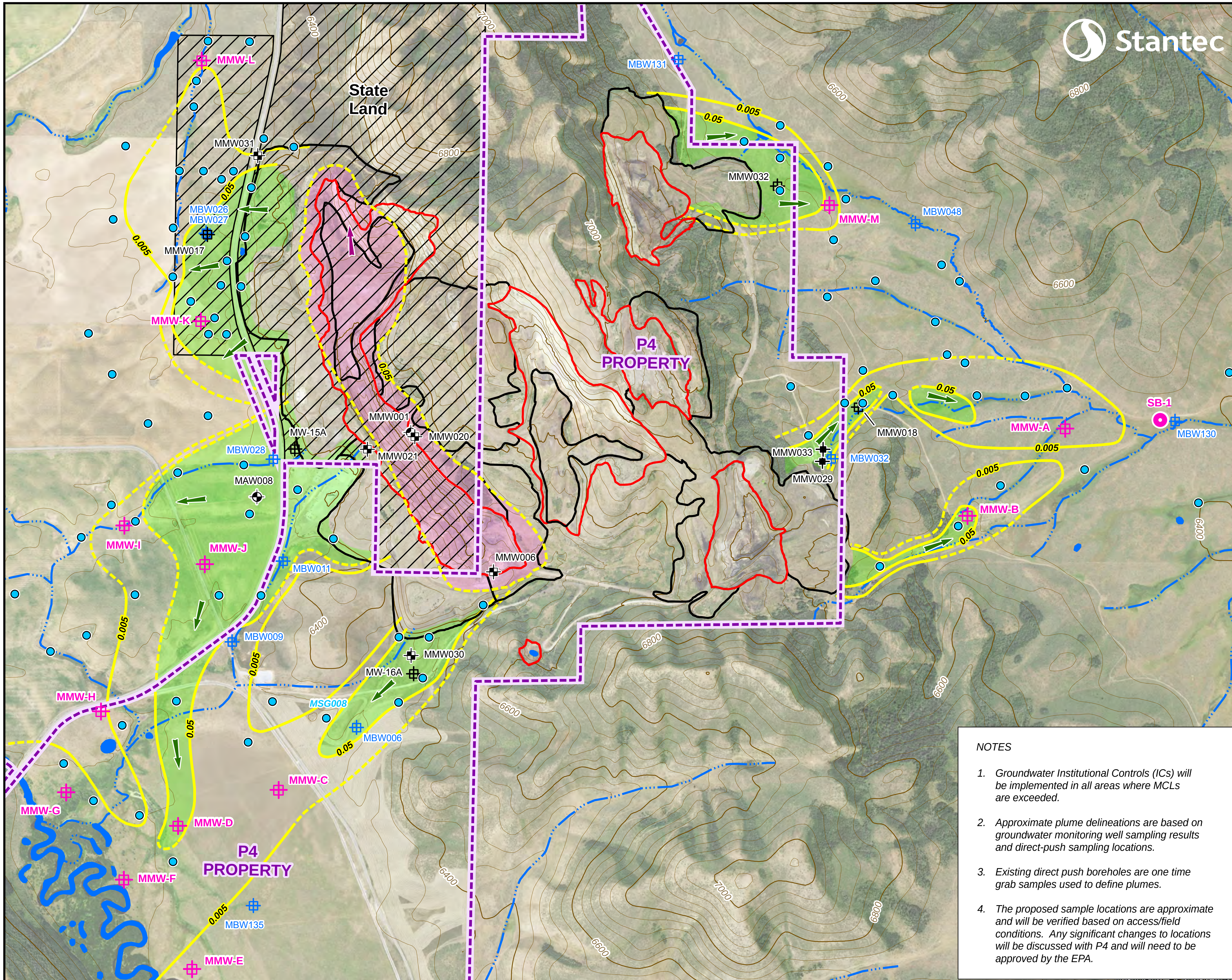
The proposed sample locations are approximate and will be verified based on access/field conditions. Any significant changes to locations will be discussed with P4 and will need to be approved by the EPA.

P_4 Production, LLC

BALLARD PREDESIGN STUDY WP

PROPOSED SOIL COVER CHARACTERIZATION LOCATIONS

Drawing 3-1



EXPLANATION

- Existing direct push alluvial aquifer well
- Existing agricultural, domestic or production well
- Existing local aquifer monitoring well (generally alluvial system)
- Existing intermediate aquifer monitoring well (generally Dinwoody Formation)
- Existing regional aquifer monitoring well (Wells Formation)
- Existing direct push borehole
- Proposed alluvial monitoring well
- Proposed alluvial soil boring
- Mine pit (approximate)
- Waste rock pile (approximate)
- Approximate alluvial groundwater plume >selenium MCL. (indicates approximate direction of groundwater flow.)
- Approximate Wells Formation groundwater plume >selenium MCL. (indicates approximate direction of groundwater flow.)
- Total selenium isoconcentration contour (mg/L)
- Inferred total selenium concentration contour (mg/L)

mg/L Milligrams per liter

MCL Maximum Concentration Level

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NOTES

1. Groundwater Institutional Controls (ICs) will be implemented in all areas where MCLs are exceeded.
2. Approximate plume delineations are based on groundwater monitoring well sampling results and direct-push sampling locations.
3. Existing direct push boreholes are one time grab samples used to define plumes.
4. The proposed sample locations are approximate and will be verified based on access/field conditions. Any significant changes to locations will be discussed with P4 and will need to be approved by the EPA.

P_4 Production, LLC

BALLARD PREDESIGN STUDY WP

PROPOSED MNA ALLUVIAL LOCATIONS

DRAWING 3-2

DRAWN BY D. Severson

29 May 2018

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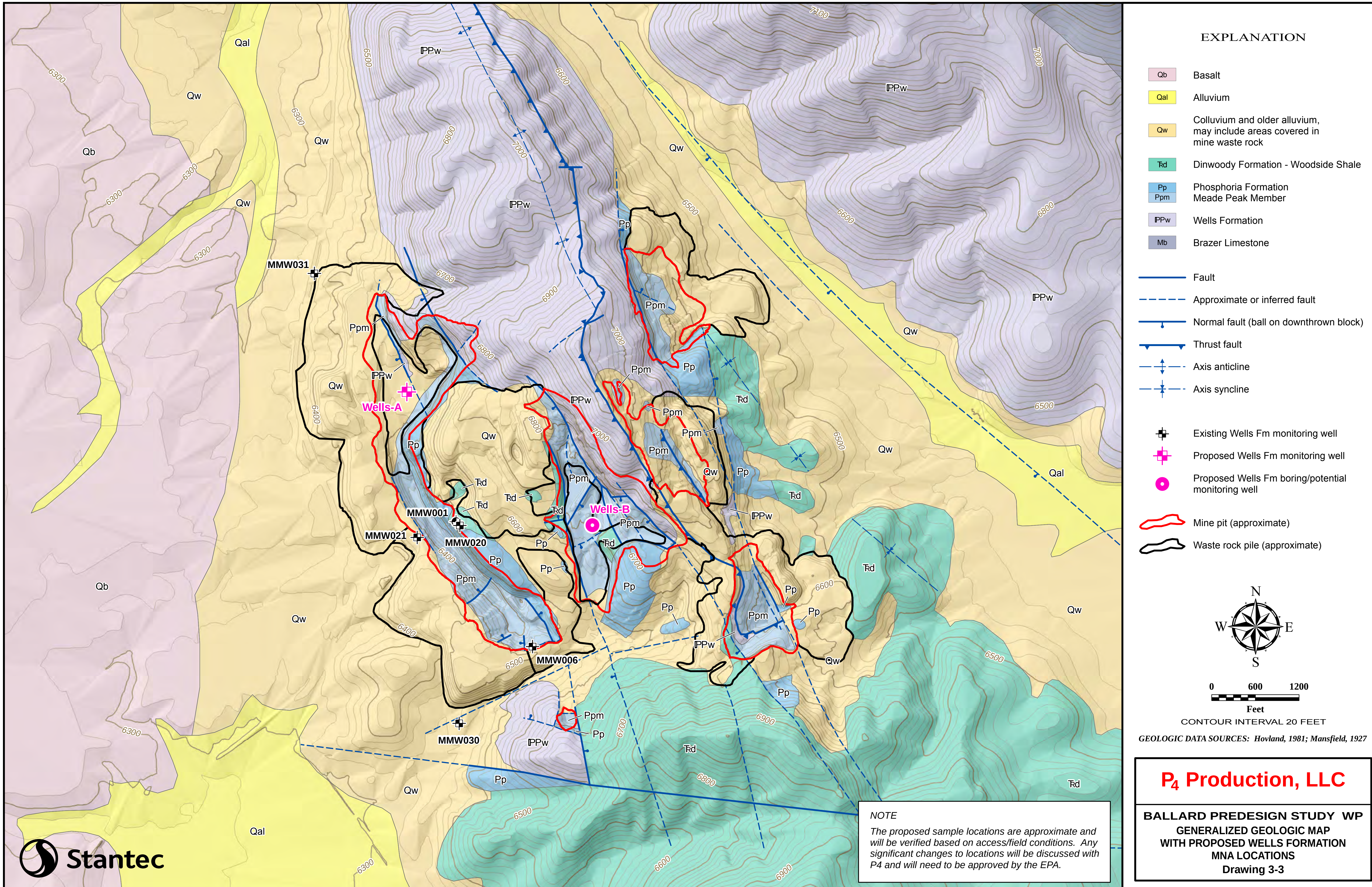


NOTE

The proposed sample locations are approximate and will be verified based on access/field conditions. Any significant changes to locations will be discussed with P4 and will need to be approved by the EPA.

P4 Production, LLC

BALLARD PREDESIGN STUDY WP

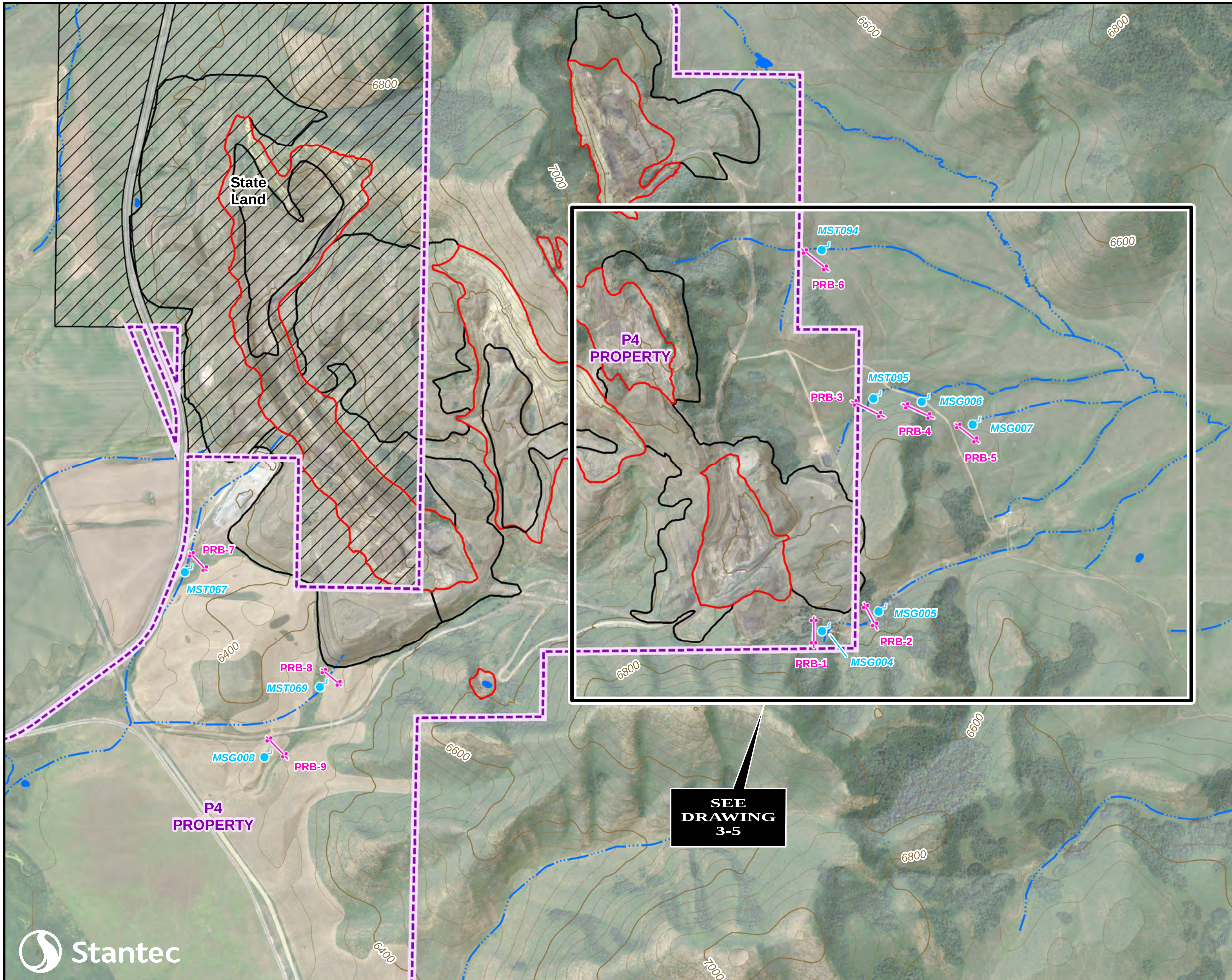
GENERALIZED GEOLOGIC MAP WITH PROPOSED WELLS FORMATION MNA LOCATIONS

Drawing 3-3

DRAWN BY D. Severson

6 Apr 2018

J:\Industrial Projects\P4 Monsanto\P4 Monsanto\Ballard Predesign Study Workplan\FIGURES\Dwg 3-3_Gen Geo Map with Prop Wells Fm MNA Locs_6Apr2018.mxd



EXPLANATION

- Mine pit (approximate)
- Waste rock pile (approximate)
- Mine-affected seep/spring
- Performance monitoring well (approximately 25 feet from PRB)
- Approximate proposed Permeable Reactive Barrier (PRB) location

Drawing depicts the FS conceptual locations of permeable reactive barriers and associated performance monitoring wells. Actual locations and associated design details will be determined during remedial design and is dependant on footprint of remedial activities in the mine pits and waste rock dumps (i.e., upland soil/waste rock source controls). Insitutional Controls (ICs), Land Use Contols (LUCs), and other long-term surface water monitoring locations will also be a component of the remedy.

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P_4 Production, LLC

BALLARD PREDESIGN STUDY WP

SEEPS AND SPRINGS AND GENERAL PRB LOCATIONS

DRAWING 3-4

DRAWN BY D. Severson

7 Mar 2018

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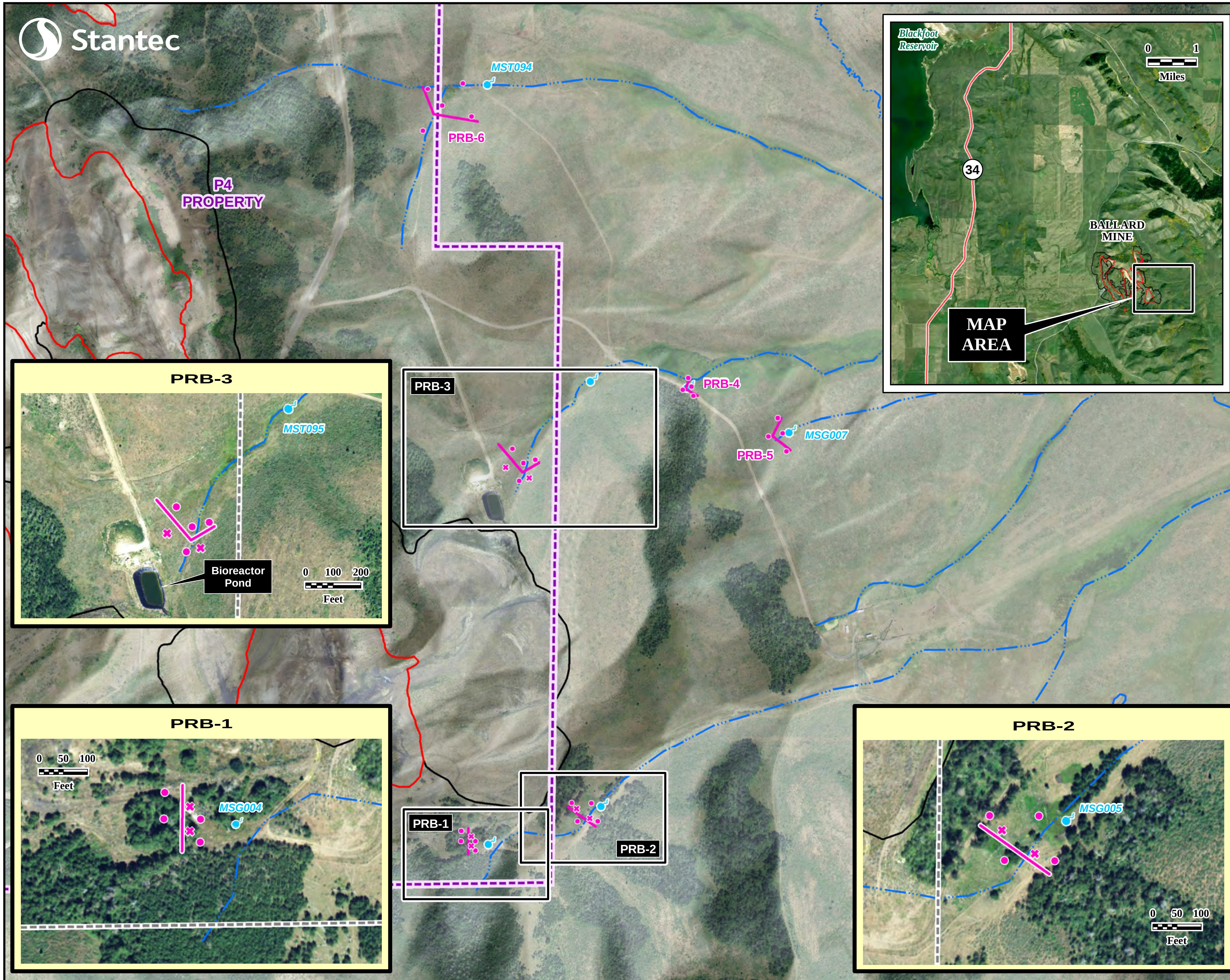

EXPLANATION

- Mine pit (approximate)
- Waste rock pile (approximate)
- Proposed test pit
- Mine-affected seep/spring
- Proposed temporary/permanent monitoring location
- Approximate PRB location

NOTES

1. *Engineered wetlands to be evaluated as a polishing step at select PRB locations*
2. *The proposed sample locations are approximate and will be verified based on access/field conditions. Any significant changes to locations will be discussed with P4 and will need to be approved by the EPA.*

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P_4 Production, LLC

BALLARD PREDESIGN STUDY WP

PROPOSED PRB CHARACTERIZATION LOCATIONS

DRAWING 3-5

DRAWN BY D. Severson
29 May 2018
J:\Industrial Projects\P4 Monsanto\P4 Monsanto\Ballard Predesign Study Workplan\FIGURES\Dwg 3-5_Ballard_Prop PRB Characterization Locs_29May2018.mxd

TABLES

TABLE 2-1
DATA QUALITY OBJECTIVES

Task	Step 1 –State the Problem	Step 2 – Identify the Goals of the Study	Step 3 –Identify Information Inputs	Step 4 – Define the Boundaries of the Study	Step 5 – Develop the Analytic Approach	Step 6 – Specify Performance Goals or Acceptance Criteria	Step 7 – Develop the Plan for Obtain Data
1. Cover Material	Characterization data are needed to help determine the available quantity and suitability of the alluvial material to be used to cap the waste rock piles at the Site.	Determine the horizontal and vertical extent of alluvium southwest of the Site and evaluate the geotechnical and agronomic properties for use as cover material.	• Soil stratigraphy, geotechnical and agronomic properties	• Spatial boundary: locations southwest of the Site • Vertical boundary: Maximum depth to groundwater (10 to 150 ft) • Temporal boundary: Drilling and sampling are planned for summer 2018.	• Drill 6 boreholes and excavate 14 test pits • Collect soil samples	Data must meet approved usability as defined in Section 7.0 of this plan.	• Sections 3.0 and 4.0 and Table 3-1 provide sample rationale, design, and field methods based on existing knowledge from previous boreholes and test pits.
2. MNA Evaluation	Additional data are needed to support previous MNA evaluations, address A/T comments and data gaps, and update the MNA conceptual model.	Collect soil/rock aquifer solid samples and groundwater samples from the alluvial and Wells Formation aquifers to confirm plume stability and evaluate the mechanism(s) and rate of attenuation processes for MNA at the Site. Sample locations will also support LTM of Site groundwater.	• Soil/rock chemistry and mineralogy, including leaching and attenuation testing • Groundwater chemistry and contaminant speciation	• Spatial boundary: locations within and downgradient of shallow groundwater plumes on the east and west sides of the Site. • Vertical boundary: Maximum depth of 40 feet bgs in alluvium, 200 feet bgs in Wells Formation • Temporal boundary: Drilling and sampling are planned for summer 2018.	• Drill 16 boreholes (14 alluvial and 2 Wells Formation) • Install monitor wells in 14 of the boreholes (13 alluvial and 1 Wells Formation monitoring well(s)) • Collect soil samples, groundwater samples, and water level measurements	Data must meet approved usability as defined in Section 7.0 of this plan.	• Sections 3.0 and 4.0 and Table 3-1 provide sample rationale, design, and field methods based on existing knowledge from monitor wells/direct-push boreholes. • Field and laboratory QA/QC requirements in Section 7.0 and Appendix B.
3. PRBs	Characterization data are needed to support the evaluation of PRBs at Phase I seep/spring locations on the east side of the Site.	Collect stratigraphy and hydraulic characteristics to determine design specifications (e.g., width, depth, flow directions residence time) for PRBs. In addition, collect data to assess potential effects of altered groundwater redox conditions on existing aquifer solids metals concentrations.	• Stratigraphy in vicinity of PRBs including evaluation of preferential flow paths • Groundwater elevations • Hydraulic Conductivity • Soil and groundwater chemistry including leaching testing	• Spatial boundary: seep spring locations located east of the Site as shown on Drawing 3-5 • Vertical boundary: Maximum depth of 20 feet bgs • Temporal boundary: Drilling and sampling are planned for summer 2018.	• Drill 4 boreholes and excavate 2 test pits along and upgradient and downgradient of the 3 proposed PRB alignments • Install piezometers in each of the boreholes • Collect soil samples, groundwater samples, and water level measurements • Perform slug tests on the piezometers	Data must meet approved usability as defined in Section 7.0 of this plan.	• Sections 3.0 and 4.0 and Table 3-1 provide sample rationale, design, and field methods based on existing knowledge from seep/spring data. • Field and laboratory QA/QC requirements in Section 7.0 and Appendix B.

TABLE 3-1 SAMPLE LOCATIONS AND RATIONALE					
Location ID	**Type**	**Drilling Method/ ~Total Depth**	**Samples**	**Analytes**	**Rationale**
Soil Cover Geotechnical Investigation					
TP18-01 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2]	Dig test pits to document lithology of alluvium/colluvium deposits and obtain soil samples to determine geotechnical/agronomic parameters for use in evaluation of borrow source for the proposed evapotranspiration cover. Topsoil samples at select test pits (7) to be analyzed for agronomic properties. Three samples per test pit to be submitted for analysis of geotechnical parameters. Two non-composited samples of distinct layers for geotechnical samples, one composite sample composed of soils from each stratigraphic unit.
TP18-02 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2] Agronomic Parameters[3]	
TP18-03 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2]	
TP18-04 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2]	
TP18-05 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2] Agronomic Parameters[3]	
TP18-06 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2]	
TP18-07 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2] Agronomic Parameters[3]	
TP18-08 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2]	
TP18-09 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2]	
TP18-10 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2] Agronomic Parameters[3]	
TP18-11 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2] Agronomic Parameters[3]	
TP18-12 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2] Agronomic Parameters[3]	
TP18-13 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2]	
TP18-14 (Drawing 3-1)	Test Pit	Excavator[1]	Soil/Composite Soil	Geotechnical Parameters[2] Agronomic Parameters[3]	
SCB18-01 (Drawing 3-1)	Soil Boring	HSA/SONIC 80 ft bgs	Composite Soil	Geotechnical Parameters[2]	Drill borings to document lithology of colluvium/alluvium deposits and obtain soil samples to determine geotechnical/agronomic parameters for use in evaluation of borrow source for the proposed evapotranspiration cover. One sample per boring to be submitted for analysis of geotechnical parameters (6 total). Sample to be composite of samples taken every 5 feet.
SCB18-02 (Drawing 3-1)	Soil Boring	HSA/SONIC 60 ft bgs	Composite Soil	Geotechnical Parameters[2]	
SCB18-03 (Drawing 3-1)	Soil Boring	HSA/SONIC 40 ft bgs	Composite Soil	Geotechnical Parameters[2]	
SCB18-04 (Drawing 3-1)	Soil Boring	HSA/SONIC 40 ft bgs	Composite Soil	Geotechnical Parameters[2]	

TABLE 3-1 SAMPLE LOCATIONS AND RATIONALE					
Location ID	**Type**	**Drilling Method/ ~Total Depth**	**Samples**	**Analytes**	**Rationale**
SCB18-05 (Drawing 3-1)	Soil Boring	HSA/SONIC 40 ft bgs	Composite Soil	Geotechnical Parameters[2]	
SCB18-06 (Drawing 3-1)	Soil Boring	HSA/SONIC 60 ft bgs	Composite Soil	Geotechnical Parameters[2]	
Alluvial MNA Investigation – Monitoring Wells					
MMW-A (Drawing 3-2)	Monitor Well	HSA/SONIC ~25 ft	Groundwater only	MNA parameters[4] Metals[5]	Drill and install a monitor well to obtain MNA parameters and LTM water quality downgradient of alluvial plume on the southeast side of the mine. No existing wells in vicinity within the plume. Collect a groundwater sample.
MMW-B (Drawing 3-2)	Monitor Well	HSA/SONIC ~25 ft	Aquifer Matrix Groundwater	Metals[5] TIC/TOC CEC paste pH SEP MNA parameters[4] Metals[5] Selenium speciation	Drill and install a monitor well to obtain MNA parameters and LTM water quality data within an alluvial plume on the southeast side of the mine. No existing wells in vicinity of the plume. Collect 1-2 aquifer solids samples and a groundwater sample.
MMW-C (Drawing3-2)	Monitor Well	HSA/SONIC ~25 ft	Aquifer Matrix Groundwater	Metals[5] TIC/TOC CEC paste pH XRD Mineralogy Batch Tests MNA parameters[4] Metals[5]	Drill and install a monitor well to obtain MNA parameters and LTM water quality data downgradient of alluvial plume on the southwest side of the mine (downgradient of MBW006). No existing wells in vicinity of the plume. Collect 1-2 aquifer solids samples from unimpacted alluvium and a groundwater sample.
MMW-D (Drawing 3-2)	Monitor Well	HSA/SONIC ~10 ft	Groundwater only	MNA parameters[4] Metals[5]	Drill and install a monitor well to obtain MNA parameters and LTM water quality within an alluvial plume on southwest side of the mine. No existing wells in vicinity of the plume. Collect a groundwater sample.

TABLE 3-1 SAMPLE LOCATIONS AND RATIONALE					
Location ID	**Type**	**Drilling Method/ ~Total Depth**	**Samples**	**Analytes**	**Rationale**
MMW-E (Drawing 3-2)	Monitor Well	HSA/SONIC ~20 ft	Aquifer Matrix Groundwater	Metals[5] TIC/TOC CEC paste pH SEP XRD Mineralogy Batch Tests MNA parameters[4] Metals[5]	Drill and install a monitor well to obtain MNA parameters downgradient of alluvial plumes on the <u>southwest</u> side of the mine near the Blackfoot River. No existing wells in the vicinity. Collect 1-2 aquifer solids samples from unimpacted alluvium and a groundwater sample.
MMW-F (Drawing 3-2)	Monitor Well	HSA/SONIC ~20 ft	Aquifer Matrix Groundwater	Metals[5] TIC/TOC CEC paste pH XRD Mineralogy Batch Tests MNA parameters[4] Metals[5]	Drill and install monitor well to obtain MNA parameters and LTM water quality downgradient of alluvial plumes on the <u>southwest</u> side of the mine near the Blackfoot River. No existing wells in vicinity. Collect 1-2 aquifer solids samples from unimpacted alluvium and a groundwater sample.
MMW-G (Drawing 3-2)	Monitor Well	HSA/SONIC ~20 ft	Aquifer Matrix Groundwater	Metals[5] TIC/TOC CEC paste pH XRD Mineralogy MNA parameters[4] Metals[5]	Drill and install a monitor well to obtain MNA parameters and LTM water quality downgradient of alluvial plumes on the <u>southwest</u> side of the mine near the Blackfoot River. No existing wells in vicinity. Collect 1-2 aquifer solids samples from alluvium and a groundwater sample.
MMW-H (Drawing 3-2)	Monitor Well	HSA/SONIC ~20 ft	Groundwater only	MNA parameters[4] Metals[5]	Drill and install a monitor well to obtain MNA parameters downgradient of alluvial plume on <u>west</u> side of the mine. No existing wells in vicinity. No existing wells at edge of the plume. Collect a groundwater sample.
MMW-I (Drawing 3-2)	Monitor Well	HSA/SONIC ~20 ft	Groundwater only	MNA parameters[4] Metals[5]	Drill and install a monitor well to obtain MNA parameters and LTM water quality within an alluvial plume on <u>west</u> side of the mine. No existing wells at edge of the plume. Collect a groundwater sample.

TABLE 3-1 SAMPLE LOCATIONS AND RATIONALE					
Location ID	**Type**	**Drilling Method/ ~Total Depth**	**Samples**	**Analytes**	**Rationale**
MMW-J (Drawing 3-2)	Monitor Well	HSA/SONIC ~10 ft	Aquifer Matrix Groundwater	Metals[5] TIC/TOC CEC paste pH SEP MNA parameters[4] Metals[5] Selenium speciation	Drill and install a monitor well to obtain MNA parameters and LTM water quality within an alluvial plume on <u>west</u> side of the mine (vicinity of MAW008). No existing wells in vicinity of the plume. Collect 1-2 aquifer solids samples from alluvium and a groundwater sample.
MMW-K (Drawing 3-2)	Monitor Well	HSA/SONIC ~20 ft	Groundwater only	MNA parameters[4] Metals[5] Selenium speciation	Drill and install a monitor well to obtain MNA parameters and LTM water quality within an alluvial plume on <u>west</u> side of the mine (south of MBW026/MBW027). Collect a groundwater sample.
MMW-L (Drawing 3-2)	Monitor Well	HSA/SONIC ~20 ft	Groundwater only	MNA parameters[4] Metals[5]	Drill and install a monitor well to obtain MNA parameters and LTM water quality within an alluvial plume on <u>northwest</u> side of the mine (north of MBW026/MBW027). No existing wells at edge of the plume. Collect a groundwater sample.
MMW-M (Drawing 3-2)	Monitor Well	HSA/SONIC ~20 ft	Groundwater only	MNA parameters[4] Metals[5]	Drill and install a monitor well to obtain MNA parameters and LTM water quality within an alluvial plume on <u>northeast</u> side of the mine (east of MMW032). No existing wells at edge of the plume. Collect a groundwater sample.
Alluvial MNA Investigation – Boreholes					
SB-1 (Drawing 3-2)	Borehole	HSA/SONIC ~25 ft	Aquifer Matrix	Metals[5] TIC/TOC CEC paste pH SEP XRD Mineralogy Batch Tests	Drill a boring and collect aquifer matrix samples from unimpacted alluvium near MBW130 to support MNA evaluation. Collect 2 aquifer matrix samples.

TABLE 3-1 SAMPLE LOCATIONS AND RATIONALE					
Location ID	**Type**	**Drilling Method/ ~Total Depth**	**Samples**	**Analytes**	**Rationale**
TP18-06 (Drawing 3-2)	Test Pit	Excavator ~20 ft	Aquifer Matrix	Metals[5] TIC/TOC CEC paste pH XRD Mineralogy Batch Tests	Excavate a test pit and collect aquifer matrix samples from unimpacted alluvium near MBW135 to support MNA evaluation. Collect 2 aquifer matrix samples.
Wells Formation MNA Investigation – Monitoring Well/Borehole					
Wells-A (Drawing 3-3)	Monitor Well	Air Rotary or Core 200 ft	Aquifer Matrix Groundwater	Metals[5] TIC/TOC CEC paste pH SEP (if impacted) XRD Mineralogy Batch Tests MNA parameters[4] Metals[5]	Collect aquifer matrix material from upper Wells Formation sandstone units north part of West Pit that transmit water and a groundwater sample to support MNA evaluation. Drill well to collect up to 3 aquifer solids samples and a groundwater sample from potentially downgradient and potentially impacted Wells Fm. well beneath partial pit backfill.
Wells-B (Drawing 3-3)	Borehole	Air Rotary or Core 150 ft	Aquifer Matrix Groundwater (if encountered)	Metals[5] TIC/TOC CEC paste pH XRD Mineralogy Batch Tests MNA parameters[4] Metals[5]	Collect aquifer matrix material from upper Wells Formation sandstone units near 2016 exploration drill hole BLD16-04V1 to support MNA evaluation. Drill boring to collect up to 3 aquifer solids samples from unimpacted Wells Formation area. Groundwater not identified in nearby 2016 exploration RC boring. Collect grab sample of groundwater, if encountered.

TABLE 3-1 SAMPLE LOCATIONS AND RATIONALE					
Location ID	**Type**	**Drilling Method/ ~Total Depth**	**Samples**	**Analytes**	**Rationale**
Phase I PRB – East Side Investigations					
PRB-1 (Drawings 3-4 and 3-5)	Piezometer and Test Pits	HSA/ SONIC and Excavator <20 ft	Aquifer Matrix Groundwater	Metals[5] SEP SEP modified GW Elevation Hydraulic Cond. General Water Quality Parameters[6] Metals[5]	Collect geochemical and hydrogeologic information to design a PRB upgradient of MSG004. Install 4 piezometers upgradient and downgradient from potential PRB location. Minimum of 3 piezometers required to determine groundwater flow direction and hydraulic gradient. Water levels and slug testing from each piezometer to determine groundwater flow direction and estimate residence time. Excavate 1-2 test pits to identify potential preferential flow paths and depths that PRBs should be installed. Collect aquifer matrix samples at test pit locations. Use piezometers as performance monitoring locations for PRBs, if possible.
PRB-2 (Drawings 3-4 and 3-5)	Piezometer and Test Pits	HSA/ SONIC and Excavator <20 ft	Aquifer Matrix Groundwater	Metals[5] SEP SEP modified GW Elevation Hydraulic Cond. General Water Quality Parameters[6] Metals[5]	Collect geochemical and hydrogeologic information to design a PRB upgradient of MSG005. Install 4 piezometers upgradient and downgradient from potential PRB location. Minimum of 3 piezometers required to determine groundwater flow direction and hydraulic gradient. Water levels and slug testing from each piezometer to determine groundwater flow direction and estimate residence time. Excavate 1-2 test pits to identify potential preferential flow paths and depths that PRBs should be installed. Collect aquifer matrix samples at test pit locations. Use piezometers as performance monitoring locations for PRBs, if possible.

TABLE 3-1 SAMPLE LOCATIONS AND RATIONALE					
Location ID	**Type**	**Drilling Method/ ~Total Depth**	**Samples**	**Analytes**	**Rationale**
PRB-3 (Drawings 3-4 and 3-5)	Piezometer and Test Pits	HSA/ SONIC and Excavator <20 ft	Aquifer Matrix Groundwater	Metals[5] SEP SEP modified GW Elevation Hydraulic Cond. General Water Quality Parameters[6] Metals[5]	Collect geochemical and hydrogeologic information to design a PRB upgradient of MST095 and below the test bioreactor pond. Install 4 piezometers upgradient and downgradient from potential PRB location. Minimum of 3 piezometers required to determine groundwater flow direction and hydraulic gradient. Water levels and slug testing from each piezometer to determine groundwater flow direction and estimate residence time. Excavate 1-2 test pits to identify potential preferential flow paths and depths that PRBs should be installed. Collect aquifer matrix samples at test pit locations. Use piezometers as performance monitoring locations for PRBs, if possible.

TABLE 3-1 SAMPLE LOCATIONS AND RATIONALE					
Location ID	**Type**	**Drilling Method/ ~Total Depth**	**Samples**	**Analytes**	**Rationale**

Notes:

1. Depth of test pits will range from 5-20 ft depending on depth of groundwater and alluvium/colluvium.
2. Geotechnical parameters include: Organic content, Atterberg Limits, USCS Classification, specific gravity, grain size distribution, hydrometer, standard proctor, crumb test, permeability (falling head). 50% of geotechnical samples will be randomly selected and analyzed for soil water characteristic testing (double dispersion)
3. Agronomic parameters include: arsenic, cadmium, molybdenum, selenium, uranium, souble boron, souble calcium, soluble magnesium, phosphorus, souble potassium, soluble sodium, CEC, conductivity, pH, total carbon, total organic carbon, organic matter, saturation percent, sulfur, nitrate as N, nitrate/nitrite, nitrite as N, nitrogen as ammonia.
4. MNA parameters for groundwater include the following field parameters: pH, conductivity, DO, ferrous iron, ORP, turbidity, and temperature and the following laboratory parameters: major cations and anions, nitrate/nitrite, and TOC/ DOC.
5. Metals for aquifer matrix and groundwater material include: aluminum, arsenic, cadmium, iron, manganese, and selenium. Aluminum will not be collected at the PRB investigation locations.
6. General water quality parameters for the PRB investigation include: major cations and anions

CEC – cation exchange capacity
DO – dissolved oxygen
DOC – dissolved organic carbon
HSA – hollow stem auger
LTM – long-term monitoring
ORP – oxidation reduction potential
PRB – permeable reactive barrier
SEP – sequential extraction procedure
TIC – total inorganic carbon
TOC – total organic carbon

TABLE 4-1
CALIBRATION AND MAINTENANCE REQUIREMENTS FOR FIELD EQUIPMENT*

Field Parameter	Required Procedure	Minimum Frequency	Required Equipment or Calibration Fluids
pH	2-point calibration	Each day prior to sampling and end of day	One pH buffer (7 pH), Reference Standard
Temperature	N/A	N/A	N/A
Dissolved Oxygen	Atmospheric calibration	Each day prior to sampling and end of day	Atmospheric oxygen with elevation
Conductivity and Specific Conductivity	1-point reference	Each day prior to sampling and end of day	Reference Standard
ORP	1-point reference	Each day prior to sampling and end of day	Reference Standard
Turbidity	1-point calibration	Each day prior to sampling and end of day	Reference Standard
Ferrous Iron	1-point calibration	Each day prior to sampling and end of day	Reference Standard

Notes:
*In the event of a discrepancy, the manufacturer's instruction manual shall take precedence.

TABLE 5-1 REQUIREMENTS FOR CONTAINERS, PRESERVATION TECHNIQUES, SAMPLE VOLUMES, AND HOLDING TIMES[a]					
Parameter[a]	**Method**	**Sample Container**	**Preservative**	**Sample Preparation Method**	**Maximum Holding Time (Days)**
Soils for Cover Investigation					
Total Metals	EPA 6020A/6010B	1-gallon plastic bag	None	3050B[b]	180
Cation Exchange Capacity (CEC)	USDA No. 60 (19)		None	None	180
Conductivity	SM 2510B		None	USDA No. 60 (2)	180
Nitrate, N - Soluble	calculation		None	None	2
Nitrate/Nitrite, N - Soluble	EPA 353.2		None	ASA No. 9 10-2.3.2	2
Nitrite, N - Soluble	EPA 353.2		None	ASA No. 9 10-2.3.2	2
Nitrogen, ammonia – KCL Extractable	EPA 350.1		None	ASA No. 9 33-3.2.2	28
Organic Matter	USDA No. 60 (24)		None	None	180
Paste pH	EPA 600		None	None	180
Carbon, total	ASA No. 9 29-2,2,4		None	None	180
Carbon, total organic (TOC)	ASA No. 9 29-2,2,4		None	None	28
Saturation Percent	USDA No. 60 (2)		None	None	180
Sulfur, total	ASTM D-4239-85C		None	None	180

TABLE 5-1 REQUIREMENTS FOR CONTAINERS, PRESERVATION TECHNIQUES, SAMPLE VOLUMES, AND HOLDING TIMES[a]					
Parameter[a]	**Method**	**Sample Container**	**Preservative**	**Sample Preparation Method**	**Maximum Holding Time (Days)**
Aquifer Solids for MNA and PRB Investigation					
Total Metals	EPA 6010B/6020A	1-gallon plastic bag	None	3050B[b]	180
CEC	USDA No. 60 (19)		None	None	180
Paste pH	EPA 600		None	None	180
Carbon, total	ASA No. 9 29-2,2,4		None	None	28
Carbon, total organic (TOC)	ASA No. 9 29-2,2,4		None	None	28
Carbon, total inorganic (TIC)	ASA No. 9 29-2,2,4		None	None	28
Sequential Extraction Procedure	Tessier method[c]	1-gallon plastic bag	None	None	180
Batch Sorption Test	ASTM D4646-16 (Modified)		None	None	180
Mineralogy	XRD		None	None	NA
Anoxic Leach	Tessier method Modified[d]		None	None	180
Groundwater for MNA and PRB Investigations					
Dissolved and Total Metals	EPA 6010B and 6020A	250 mL HDPE 250 mL HDPE	Field filter; HNO_3 pH < 2 (dissolved) ≤ 4 °C HNO_3 pH <2 (total) ≤ 4 °C	3010A	180

TABLE 5-1 REQUIREMENTS FOR CONTAINERS, PRESERVATION TECHNIQUES, SAMPLE VOLUMES, AND HOLDING TIMES[a]					
Parameter[a]	**Method**	**Sample Container**	**Preservative**	**Sample Preparation Method**	**Maximum Holding Time (Days)**
Chloride and Sulfate	EPA 300.0	250 mL HDPE	Field filter; ≤ 4 °C	Dissolved (field filtered)	28
Alkalinity	SM 2320B	250 mL HDPE	≤ 4° C	Total (raw)	14
Carbon, dissolved organic (DOC) Carbon, total organic (TOC)	SM 5310B	250 mL Glass 250 mL Glass	Field filter; H_2SO_4 pH < 2 (dissolved) ≤ 4 °C H_2SO_4 pH < 2 (total) ≤ 4 °C	Dissolved (field filtered) Total (raw)	28
Nitrate, N	calculation	250 mL HDPE	≤ 4° C	Total (raw)	2
Nitrate/Nitrite, N	EPA 353.2				
Nitrite, N					
Selenium Speciation	SM 3114B/C	250 mL Glass 250 mL Glass 250 mL Glass	Field filter; ≤ 4 °C Field filter; HNO_3 pH < 2 (dissolved) ≤ 4 °C Field filter; HNO_3 pH < 2 (dissolved) ≤ 4 °C	Dissolved (field filtered)	14
Ferrous Iron	Hach 8146[e]	25 mL glass	None	Total (raw)	1

TABLE 5-1 REQUIREMENTS FOR CONTAINERS, PRESERVATION TECHNIQUES, SAMPLE VOLUMES, AND HOLDING TIMES[a]					
Parameter[a]	Method	Sample Container	Preservative	Sample Preparation Method	Maximum Holding Time (Days)

Notes:
[a]Refer to Tables 5-2, 5-3 and 5-4 for metal, cation, anion parameters and method detection limits (MDLs).
[b] EPA Method 3050B is an extraction method for As, Cd, Mo, Se, U, and P. Extraction method for soluble Ca, Mg, K, Na is saturated paste and soluble B is hot water.
[c]Tessier, et. al., 1979. See **Appendix B**.
[d]Tessier, et. al., 1979 sequence 3 (as written) only for specified samples. See **Appendix B**.
[e]See ferrous iron method in **Appendix B**. This testing is conducted in the field.
CEC – cation exchange capacity
DOC – dissolved organic carbon
HDPE – high-density polyethylene
mL – Milliliter
NA – not applicable
TIC – total inorganic carbon
TOC – total organic carbon

TABLE 5-2 SOIL COVER INVESTIGATION METAL ANALYTES				
Parameter	**Method**	**MDL**	**SL[a]**	**Reporting Units**
Arsenic	6020A	0.1	15.6	mg/kg
Boron, soluble	6010B	1	NA	mg/kg
Cadmium	6020A	0.05	41.0	mg/kg
Calcium, soluble	6010B	10	NA	mg/kg
Magnesium, soluble	6010B	20	NA	mg/kg
Molybdenum, soluble	6020A	0.25	NA	mg/kg
Phosphorus	6010B	10	NA	mg/kg
Potassium, soluble	6010B	20	NA	mg/kg
Selenium	6020A	0.05	29.0	mg/kg
Sodium, soluble	6010B	20	NA	mg/kg
Uranium	6020A	0.05	36.0	mg/kg

Notes:
MDL – method detection limit
NA – not applicable
SL – screening level
[a]Soil metals screening criteria is 95-95 upper tolerance limit (UTL) background threshold value (MWH, 2015)

TABLE 5-3 MNA AND PRB INVESTIGATION AQUIFER SOLIDS ANALYTES					
Parameter	**Method**	**MDL**	**SL[a]**	**Reporting Units**	**Test Type**
Aluminum	6010B	3	NA	mg/kg	MNA total metals
Arsenic	6020A	0.1	15.6	mg/kg	PRB and MNA total metals, batch, SEP, leach tests
Cadmium	6020A	0.05	41.0	mg/kg	PRB and MNA total metals, batch, SEP, leach tests
Iron	6010B	2	NA	mg/kg	PRB and MNA total metals, SEP, leach test
Manganese	6010B	0.5	3,460	mg/kg	PRB and MNA total metals, SEP, leach test
Selenium	6020A	0.05	29.0	mg/kg	PRB and MNA total metals, batch, SEP, leach tests
CEC	USDA No. 60 (19)	0.3	NA	meq/L	MNA
Paste pH	EPA 600	0.1	NA	s.u.	MNA
Carbon, total	ASA No. 9 29-2,2,4	0.1	NA	%	MNA
TOC	ASA No. 9 29-2,2,4	0.1	NA	%	MNA
TIC	ASA No. 9 29-2,2,4	0.1	NA	%	MNA

Notes:
% - percent
MDL – method detection limit
Meq/L – milliequivalents per liter
mg/kg – milligram per kilogram
NA – not applicable
SL – screening level
s.u. – standard units
TIC – total inorganic carbon
TOC – total organic carbon
[a]Soil metals screening criteria is 95- 95 upper tolerance limit (UTL) background threshold value (MWH, 2015)

TABLE 5-4
MNA AND PRB INVESTIGATION GROUNDWATER ANALYTES

Parameter	Basis	Method	MDL	SL[a]	Reporting Units	Test Type
Aluminum	total/dissolved	6010B	0.03	0.2	mg/L	MNA parameter
Alkalinity	total	SM 2320B	2	NA	mg/L	MNA and PRB parameter
Arsenic	total/dissolved	6020A	0.0002	0.01	mg/L	MNA and PRB parameter
Cadmium	total/dissolved	6020A	0.0001	0.005	mg/L	MNA and PRB parameter
Calcium	dissolved	6010B	0.1	NA	mg/L	MNA and PRB parameter
Chloride	dissolved	300.0	0.5	250	mg/L	MNA and PRB parameter
Iron	total/dissolved	6010B	0.02	0.3	mg/L	MNA and PRB parameter
Magnesium	dissolved	6010B	0.2	NA	mg/L	MNA and PRB parameter
Manganese	total/dissolved	6010B	0.005	0.05	mg/L	MNA and PRB parameter
Nitrate	total	calculation	0.01	10	mg/L	MNA parameter
Nitrite	total	353.2	0.01	1	mg/L	MNA parameter
Nitrate/nitrite	total	353.2	0.02	10	mg/L	MNA parameter
Potassium	dissolved	6010B	0.2	NA	mg/L	MNA and PRB parameter
Selenium	total/dissolved	6020A	0.0001	0.05	mg/L	MNA and PRB parameter
Selenium4+6, organic	dissolved	SM2114B/C	0.001	0.05	mg/L	MNA parameter
Sodium	dissolved	6010B	0.2	NA	mg/L	MNA and PRB parameter
Sulfate	dissolved	300.0	0.5	500	mg/L	MNA and PRB parameter
DOC	dissolved	415.3	1	NA	mg/L	MNA parameter
TOC	total	415.3	1	NA	mg/L	MNA parameter

Notes:
MDL – method detection limit
mg/L – milligram per liter
NA – not applicable
SL – screening level
[a]USEPA primary and secondary Maximum Contaminant Level (MCL), National Primary Drinking Water Regulations

APPENDICES

APPENDIX A

STANDARD OPERATION PROCEDURES

APPENDIX A-1

BOREHOLE DRILLING AND LOGGING, MONITORING WELL INSTALLATION, AND AQUIFER TESTING

Borehole Drilling and Logging
Monitoring Well Installation
Aquifer Testing

Standard Operating Procedures

JULY 2010

Prepared by:

MWH

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LIST OF ATTACHMENTS

1.0 INTRODUCTION

The purpose of this document is to define the standard procedures for drilling, logging, testing, documentation, and installation of boreholes and monitoring wells. This SOP provides descriptions of equipment, field procedures, and technical procedures necessary to perform the proposed drilling and sampling activity. The procedures described herein are intended to be used with other applicable SOPs, as appropriate.

This SOP describes procedures for conducting the tasks listed below.

- Drilling boreholes
- Sampling soil and bedrock for lithologic description
- Borehole logging
- Equipment decontamination
- Well design and construction
- Well development
- Aquifer testing (slug testing)

Many terms included in this SOP may be unfamiliar to the reader. A glossary of terms is included in Attachment A.

2.0 DRILLING OPERATIONS

Drilling methods can be separated into two general types - techniques that do not use circulating fluids and techniques that use circulating fluids. The following sections discuss the drilling methods that fall into each of these two general categories that are most likely to be used for this project.

This section provides a description of the principles of operation and the applicability and implementability of the drilling methods that are proposed for this investigation. It focuses on methods and equipment that are readily available and typically applied. It is not intended to provide an all-inclusive discussion of drilling methods. Drilling will be conducted using air rotary drilling rigs, hollow stem auger (HSA) drilling rigs, and Rotasonic drilling rigs. Other alternatives that will be available are dual-tube percussion hammer and Rotary-sonic drilling. These methods are discussed below. All drillers and drilling personnel working onsite will the appropriate training (e.g., 40 hour OSHA (CFR 1910) certified and 24 hour MSHA certified). Drillers will also be available to provide additional services for minor repair or servicing of existing wells.

2.1 Drilling Methods without Circulating Fluids

2.1.1 Hollow-Stem Auger Drilling

Drilling is accomplished by rotating a pipe or rod that has a cutting bit. The common auger drilling method expected to be used is discussed in section.

Hollow-stem augers (H.S.A.) are commonly used in unconsolidated materials up to 150 feet in depth. A key advantage of H.S.A. drilling is that undisturbed soil samples can be collected through the auger, which acts as a temporary outer casing during drilling. The auger also acts as a temporary outer casing during monitoring well installation.

Hollow-stem augers consist of two parts: a tube with flights attached to the outside and connected the lead auger, and an inner pilot or center rod and bit which is removable from the center of the auger. The removable inner plug is the primary advantage of this drilling method. Withdrawing the plug while leaving the auger in place provides an open, cased hole into which soil samplers, down-hole drive hammers, instruments, casing, wire, pipe, or numerous other items can be inserted. Replacing the center bit and plug allows for continuation of the borehole.

Hollow-stem augers are specified by the inside diameter of the hollow stem, not by the hole size it drills. Hollow-stem augers are available in a variety of diameters, such as 2.5, 3.25, 3.375, 4.0, 4.25, 6.25, 6.625, 8.25, and 10.25 inches. The most commonly used sizes are 3.25 inches and 4.25 inches for soil borings that may be completed as 2-inch monitoring wells, and 6.625 inches for soil borings that may be completed as 4-inch monitoring wells.

The rotation of the augers causes the cuttings to move upward and be "smeared" along the borehole walls. This smearing may effectively seal off the upper zones thereby reducing the possibility of cross contamination of the upper zones to the deeper zones but increases the possibility of deep to shallow contamination. Conversely, smearing of clays on the borehole walls may seal off aquifers to be monitored.

Applications

- Suitable for all types of soil investigations.
- Allows good soil sampling with split-spoon samplers or Shelby tubes.
- Monitoring well installation in all unconsolidated formations.
- Can serve as temporary casing.
- Can be used in stable formations to set surface casing.

Limitations

- Difficulty in preserving sample integrity in heaving formations.
- Formation invasion by water or drilling mud if used to control heaving.
- Possible cross contamination of aquifers where annular space not positively controlled by water or drilling mud or surface casing.
- Limited diameter of augers limits casing size.
- Smearing of clays may seal off aquifer to be monitored.

2.1.2 Rotary-Sonic Drilling

Rotasonic drilling is a dual-cased drilling system that uses high frequency vibration to take continuous core samples and advance casing into the ground. The hydraulically powered drill head applies vibration to the drill string. This energy is directed down the drill string to the face of the core bit. No mud pump or air compressor is used to force cutting away from the borehole. The inner core barrel is advanced in increments into the formation, and then the outer casing is advanced down over the core barrel. The core barrel is then removed and the sample extruded into a plastic sleeve.

Applications

- Suitable for all types of soil investigations.
- Allows undisturbed soil sampling and recovery with continuous coring.
- Monitoring well installation in all unconsolidated formations.
- Waste minimization.
- Prevents cross contamination and formation mixing.

Limitations

- Slower through hard dense formations.
- Large rig and requires a support vehicle.
- Technique can create high heat, which is a concern if sampling for hydrocarbons.
- Technique is not appropriate for dense, consolidated material (rock).

2.2 Drilling Methods with Circulating Fluids

Many drilling techniques use a circulating fluid, such as water, drilling mud, air, a combination of air and water, or even a surfactant to create foam. Circulation fluids flow from the surface either through the drill pipe, out through the bit, and up the annulus between the borehole wall and the drill pipe (direct rotary) or down the borehole annulus, into the bit, and up the drill pipe (reverse rotary). Generally the up-hole velocity needed to transport cuttings to the surface is between 100 to 150 feet per minute for plain water with no additives, 80 to 120 feet per minute for high-grade bentonite drill muds, 50 to 1,000 feet per minute for foam drilling, and up to 3,000 feet per minute for air with no additives. Additives decrease the required minimum velocity. Excessive velocities can cause erosion of the borehole wall. For this project, air and/or water is the expected fluid.

The use of circulating fluids may involve the addition of chemicals to the borehole. Drilling mud utilizes bentonite clay or polymers. Additives to air drilling may include surfactants (detergents) and water mist to generate foam. Compressed air may also contain various amounts of hydrocarbon lubricants. Therefore, attention should be given to the circulating fluids and any possible additives that are used when using drilling methods utilizing circulation fluids.

2.2.1 Dual Rotary Drilling

This method is a specialized rotary or percussion drill that utilizes two independent drives, a traditional top drive to create the borehole annulus and a lower drive to advance steal casing. Both Drives operate independently to allow the drill rig to simultaneously drill a borehole and advances steel casing at different speeds and positions relative to each other. Compressed air is used to blow cutting up from the bottom of the borehole; around 50 feet bgs water is added to the aid in the removal of drill cuttings (Foremost Industries, 2003).

Applications & Advantages

- Drilling through loss circulation zones (loose sands, voids, etc.) for recovering uncontaminated disturbed samples and for testing water.
- Drilling through gravel to boulder-size material and for recovering uncontaminated disturbed samples of sand, gravel, and cobble-size material.
- Drilling deeper depths
- The drive pipe can be used as a temporary casing through the coarse aggregate deposits.

Limitations

- Thin, low pressure water bearing zones easily overlooked if drilling is not stopped at appropriate places to observe whether or not water levels are recovering.

2.2.2 Dual-tube Reverse Rotary Drilling

This method is a specialized rotary or percussion drill that uses a double-walled tubular drill rod. The circulation drilling media, compressed air or air-foam, is forced downhole through the annulus between the inner and outer rod wall. For a reverse-circulation rotary drill, the circulation media is ejected near the tool joint connection between the rotary bit and the center rod. The media circulates around the outside face of the bit to cool the bit and moves drill cuttings upward through a center opening in the bit. The cuttings are forced up the center tube to a discharge point at the hole collar. For a reverse-circulation percussion drill, the circulation media is ejected just above the drive shoe on the outer rod. The circulation media forces drill cuttings in the drive shoe upward through the center tube to a discharge point at the drill hole collar.

Applications & Advantages

- Drilling through loss circulation zones (loose sands, voids, etc.) for recovering uncontaminated disturbed samples and for testing water.
- Drilling through gravel to boulder-size material and for recovering uncontaminated disturbed samples of sand, gravel, and cobble-size material.
- Drilling deeper depths in weak formations
- The drive pipe can be used as a temporary casing through the coarse aggregate deposits.

Limitations

- Difficult to obtain accurate sampling below the water table
- Large rig and drill pipe requires a support vehicle

2.2.3 Air Rotary Down-the-Hole Hammer

This method combines percussion and air rotary drilling methods to drill. The borehole is drilled using the air rotary drilling method. A pneumatic drill, "down-the-hole", at the end of the drill pipe strikes the rock while the drill pipe is gradually rotated. Rotation helps to insure even penetration. The air used to run the drill is used to remove cuttings. Casing or drive pipe follows closely behind the rotary bit to prevent the erosion of the borehole wall.

Applications & Advantages

- Rapid drilling of unconsolidated sands, silts, and clays.
- Drilling in alluvial materials (including boulder formations).
- Casing supports borehole thereby maintaining borehole integrity and minimizing inter-aquifer cross contamination.
- Eliminates circulation problems common with direct mud rotary method.
- Good formation samples for stratigraphic evaluation.
- Minimal formation damage as casing is pulled back.

Limitations

- Thin, low pressure water bearing zones easily overlooked if drilling is not stopped at appropriate places to observe whether or not water levels are recovering.
- Samples pulverized as in all rotary drilling.
- Air may modify chemical or biological conditions.
- Difficult to obtain soil samples for chemical analysis.

2.3 Permitting

All monitoring wells and piezometers proposed to be installed will be installed and constructed in accordance with all applicable Idaho Department of Water Resources (IDWR) rules and regulations. For this CERCLA action specific permits do not need to be filed with IDWR, but all well construction needs to be consistent with IDWR rules and regulations.

A licensed drilling subcontractor registered with IDWR will conduct all drilling and well installation activities.

2.4 Sampling Methods

2.4.1 Lithologic Sampling

A field engineer/geologist will maintain a drill log noting lithology, sampling interval, and other pertinent information. It is anticipated that samples will be collected approximately every 5 feet (where possible) from the cuttings. Cuttings are collected for lithologic characterization and analytical testing and are placed in specially-designed "chip-tray" plastic containers. More details in lithologic logging can be seen in Section 3.0 and a copy of the litholgic sampling form is presented in the attachments.

2.5 Borehole or Well Abandonment

Any borehole that will not be converted into a well (e.g., soil borings, bedrock boreholes) will be abandoned according to all applicable IDWR rules and regulations. The borehole will be abandoned by pumping cement-bentonite grout to the bottom of the borehole through a tremie pipe until the borehole is filled to the ground surface with undiluted grout. Dry holes less than 15 feet deep can be filled with grout poured from the surface. After 24 hours, the abandoned borehole will be checked for grout settlement. Any settlement will be filled in with grout, using a tremie pipe if it is deeper than 15 feet. This process will be continued until firm grout remains at the ground surface. Under no circumstances, will the borehole be backfilled with the soil removed during drilling and sampling operations.

There are currently no monitoring wells slated for abandonment during the 2010 program. However, if circumstances develop where a monitoring well needs to be abandoned, the well will be abandoned according to IDWR regulations, and the proper forms will need to be filed with IDWR prior to commencement of abandonment procedures for any permitted well.

2.6 Drilling Equipment Decontamination

All equipment that may directly contact samples for chemical analysis, such as split-spoon samples or core barrels, will be decontaminated on-site. The following sampling-specific decontamination procedures will be utilized.

- Wash and scrub with detergent (laboratory grade, non-phosphate detergent)
- Rinse with potable water
- Rinse with deionized water
- Rinse with another batch of deionized water
- Air dry
- Protect from fugitive dust and vapors

3.0 BOREHOLE LOGGING - SOILS

3.1 General

The procedures described herein are applicable to logging soils and are based on the Unified Soils Classification System (USCS); ASTM Standard D 2488-93, Standard Practice for Description and Identification of Soils (Visual Manual); and ASTM Standard D 5434-93, Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock (ASTM, 1993).

Much of the information described in this section is summarized on several tables and in a USCS field guide, as shown in Attachment C. Other field guidance references also may be used according to personal preference; however, such references must be based on the USCS. Note that many references (for example, AGI Data Sheet grain size scales) are base soil classifications on the Wentworth Scale. Such scales may vary significantly from the USCS and will lead to inaccurate or inconsistent soil descriptions.

All soil logging will be documented using the Lithologic or Soil Boring Log Form included as Attachments B and D, respectively.

3.2 Geologist/Hydrogeologist

One or more geologists or hydrogeologist will accompany each operating drill rig for inspection of drilling and borehole testing work. Each individual will be responsible for only one operating rig. Once assigned to an individual borehole, that person will remain as the geologist or hydrogeologist until that borehole is completed, unless approved for replacement. The geologist or hydrogeologist will be present during the entire time that the drill rig is operating and during casing and screen installation, developing and clean-out operations.

The geologist or hydrogeologist will observe and record the drilling operations along with the characteristics of the subsurface materials. This individual will be responsible for the preparation of a separate log for each boring and will sign each log.

3.3 Definitions

Use of the USCS requires familiarity with the grain size ranges that define a particular type of soil, as well as several other physical characteristics. The grain size definitions and physical characteristics upon which soil descriptions are based are presented below. These procedures are used for soil and other unconsolidated materials.

3.3.1 Grain Sizes

USCS grain sizes are based on U.S. standard sieve sizes, which are listed below.

- Standard sieves with larger openings are named according to the size of the openings in the sieve mesh. For example, a "3-in." sieve contains openings that are 3 inches square.
- Standard sieves with smaller openings are given numbered designations that indicate the number of openings per inch. For example, a "No. 4" sieve contains 4 openings per inch.

The following grain size definitions are paraphrased from the ASTM Standard D 2488-93. Field personnel should familiarize themselves with the grain size definitions.

Boulders - Particles of rock that will not pass a 12-in. (300-mm) square opening.

Cobbles - Particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve.

Gravel - Particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

- *Coarse Gravel* - passes a 3-in. (75-mm) sieve and is retained on a 3/4-in. (19-mm) sieve
- *Fine Gravel* - passes a 3/4-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve

Sand - Particles of rock that will pass a No. 4 (0.19 in. or 4.75-mm) sieve and be retained on a No. 200 (0.003 in. or 75-μm) sieve with the following subdivisions:

- *Coarse Sand* - passes a No. 4 (0.19 in. or 4.75-mm) sieve and is retained on a No. 10 (0.08 in. or 2-mm) sieve
- *Medium Sand* - passes a No. 10 (0.08 in. or 2-mm) sieve and is retained on a No. 40 (0.017 in. or 425-μm) sieve
- *Fine Sand* - passes a No. 40 (0.017 in. or 425-μm) sieve and is retained on a No. 200 (0.003 in. or 75-μm) sieve

Silt - Soil passing a No. 200 (0.003 in. or 75-μm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air-dried. Individual silt particles are not visible to the naked eye.

Clay - Soil passing a No. 200 (0.003 in. or 75-μm) sieve that can be made to exhibit plasticity within a range of water contents and that exhibits considerable strength when air-dried. Individual clay particles are not visible to the naked eye.

3.3.2 Physical Characteristics

The following physical characteristics are used in the USCS classification for fine-grained soils. A brief definition of each physical characteristic is presented below. A determination of the type of fine-grained soil present in the sample can generally be made on the basis of plasticity, as described in Section 3.4.1.2.

Dry Strength - The ease with which a dry lump of soil crushes between the fingers.

Dilatancy Reaction - The speed with which water appears in a moist pat of soil when shaking in the hand and disappears while squeezing.

Toughness - The strength of a soil, moistened near its plastic limit, when rolled into a 1/8-inch diameter thread.

Plasticity - The extent to which a soil may be rolled into a 1/8-inch thread and re-rolled when drier than the plastic limit.

3.4 Soil Logging Procedures

The following aspects of a project must be understood before sampling and soil logging commences.

- Purpose of the soil logging (e.g., initial investigation, subsequent investigation, remediation)
- Known or anticipated hydrogeologic setting including presence of fill material, lithology, physical characteristics of the aquifer, type of aquifer, recharge/discharge conditions, aquifer thickness and ground water/conditions
- Drilling conditions
- Previous soil boring or borehole geophysical logs
- Soil sampling and geotechnical testing program
- Characteristics of potential chemical release(s) (chemistry, density, viscosity, reactivity and concentration)
- Health and Safety protection requirements
- Regulatory requirements

The procedures used to determine the correct soil sample classification are described below. These procedures are presented in Attachment C through F.

The soils should be described in terms of lithologic units, rather than on a sample-by-sample basis. Thus, a single description may cover several sample intervals, or conversely, several units may occur within a single sample interval. For a specific unit, the primary classification is described and then variations or minor changes are noted below the main description at the depth where they occur.

3.4.1 Field Classification of Soils

When naming soils, the proper USCS soil group name is given followed by the group symbol. For clarity, it is recommended that the group symbol be placed in parentheses after the written soil group name.

Soil identification using the visual-manual procedures is based on naming the portion of the soil sample that will pass a 3-in. (75-mm) sieve. Therefore, before classifying a soil, any particles larger than 3 inches (cobbles and boulders) should be removed, if possible. Estimate and note the percentage of cobbles and boulders.

Using the remaining soil, the next step of the procedure is to estimate the percentages by dry weight of the gravel, sand and fine fractions (particles passing a No. 200 sieve). The percentages shall be estimated to the closest 5%. In general, the soil is *fine-grained* (e.g., a silt or a clay) if it contains 50% or more fines and *coarse-grained* (e.g., a sand or a gravel) if it contains less than 50% fines. If one of the components is present but estimated to be less than 5%, its presence is indicated by the term *trace*. For example, "trace of fines" would be added as additional information following the formal USCS soil description.

3.4.1.1 Procedure for Identifying Coarse-Grained Soils (contain less than 50% fines)

If it has been determined that the soil contains less than 50% fines, the soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand. The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

If the soil is predominantly sand or gravel but contains an estimated 15% or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "gravel with sand (GP)." If the sample contains any cobbles or boulders, the words "with cobbles" or "with cobbles and boulders" shall be added to group name. For example: "silty gravel with cobbles (GM)."

5% or less fines. The soil is a "clean gravel" or "clean sand" if the percentage of fines is estimated to be 5% or less. "Clean" is not a formal USCS name but rather a general descriptor for implying little to no fines. Clean sands and gravels are given the USCS designation as either *well-graded* or *poorly-graded*, as described below.

Identify the soil as a *well-graded gravel* (GW) or as a *well-graded sand* (SW), if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes. Identify the soil as a *poorly-graded gravel* (GP) or as a *poorly-graded sand* (SP) if it consists predominantly of one grain size (uniformly graded) or has a wide range of sizes with some intermediate sizes obviously missing (gap- or skip-graded).

Note: When using the USCS, keep in mind the difference between grading and sorting. The term grading is used to indicate the range of particles contained in the sample. For example, a poorly-graded sand containing predominantly one grain size would be considered well-sorted and vice-versa. One notable exception to this general rule is a skip-graded (bimodally distributed) sample: a sand containing two distinct grain sizes would be considered both poorly-sorted and poorly-graded. The USCS uses only the *GRADING* descriptor in soil naming, not the sorting descriptor.

≥ 15% fines. The soil is a *silty* or *clayey gravel* or a *silty* or *clayey sand* if the percentage of fines is estimated to be 15% or more. For example, identify the soil as *clayey gravel* (GC) or a *clayey sand* (SC) if the fines are clayey. Identify the soil as a *silty gravel* (GM) or a *silty sand* (SM) if the fines are silty. The coarse-grained descriptor "poorly-graded" or "well-graded" is not included in the soil name, but rather, should be included as additional information following the formal USCS soil description.

>5% but <15% fines. If the soil is estimated to contain greater than 5% and less than 15% fines, give the soil a dual identification using two group symbols. The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a clayey/silty gravel or sand (GC, GM, SC, SM). The group name shall correspond to the first group symbol and include the words "poorly-graded" or "well-graded", plus the words "with clay" or "with silt" to indicate the character of the fines. For example, "poorly-graded gravel with silt (GP-GM)".

3.4.1.2 Procedure for Identifying Fine-Grained Soils (contain 50% or more fines)

The USCS classifies inorganic fine-grained soils according to their degree of plasticity (no or low plasticity - indicated with an "L", or high plasticity - indicated with an "H"). The field tests used to determine dry strength, dilatancy and toughness are generally too time consuming to be performed on a routine basis. Field personnel should be familiar with the definitions of the physical characteristics and the concepts of the field tests; however, field classifications will generally be based primarily on plasticity, as described in Attachment E.

Lean clay (CL) - soil has medium to high dry strength, no or slow dilatancy and medium toughness and plasticity.

Fat clay (CH) - soil has high to very high dry strength, no dilatancy and high toughness and plasticity.

Silt (ML) - the soil has no to low dry strength, slow to rapid dilatancy and low toughness and plasticity, or is nonplastic.

Elastic silt (MH) - the soil has low to medium dry strength, no to slow dilatancy and low to medium toughness and plasticity; will air dry more quickly than lean clay and have a smooth, silky feel when dry.

Organic soil (OL or OH) - the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, from black to brown, when exposed to the air. Organic soils normally will not have a high toughness or plasticity.

Other Modifiers for Use with Fine-Grained Soils:

15% to 25% coarse-grained material. If the soil is estimated to have 15% to 25% sand or gravel, or both, the words "with sand" or "with gravel" (whichever is predominant) shall be added to the group name. For example: "lean clay with sand (CL)" or "silt with gravel (ML)." If the percentage of sand is equal to the percentage of gravel, use "with sand."

≥30% coarse-grained material. If the soil is estimated to have 30% or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be the same or more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy silt (ML)", or "gravelly fat clay (CH)."

3.4.1.3 Procedure for Identifying Borderline Soils

To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example, a soil containing an estimated 50% silt and 50% fine grained sand may be assigned a borderline symbol "SM/ML." Borderline symbols should not be used indiscriminately. Every effort should be made to first place the soil into a single group and then to estimate percentages following the USCS soil description.

3.4.2 Descriptive Information for Soils

After the soil name and symbol are assigned, the soil color, consistency/density and moisture content shall be described in that order. Other information is presented later in the description, as applicable.

3.4.2.1 Color

Describe the color using the Munsell Soil Color Chart (1992). Color is an important property in identifying organic soils and may also be useful in identifying materials of similar geologic or depositional origin in a given location.

When using the Munsell Soil Color Charts, first attempt to assign the soil a general color, such as brown, gray, red, etc. Then go to the correct area in the charts and assign the applicable color name and Munsell symbol. The ability to detect minor color differences varies among people and the chance of finding a perfect color match in the charts is rare. Keeping this in mind should help field personnel avoid spending unnecessary time and confusion going through the chart pages. In addition, attempting to describe detail beyond the reasonable accuracy of field observations could lead to making poorer soil descriptions than by expressing the dominant colors simply (Munsell Soil Color Chart, 1992).

If the color charts are not being used or are unavailable, again attempt to assign general colors to soils. Comparing a particular soil sample to samples from different locations in the borehole will help keep the eye "calibrated." For example, by holding two soils together, it may become evident that one is obviously greenish-brown, while another is reddish.

3.4.2.2 Consistency & Density

For intact fine-grained soil, describe consistency as very soft, soft, medium stiff, stiff, very stiff, or hard, based on the blows per foot using a 140-pound hammer dropped 30", as described in Attachment F. If blow counts are not available, use the thumb test, as described in Attachment F to determine consistency.

For coarse-grained soils, describe density based on blows per foot as very loose, loose, medium dense, dense and very dense, as described in Attachment F. If blow counts are not available, attempt to estimate the soil density by observation, since a practical field test is not available. Be sure to clearly indicate on the field boring log if blow counts could not be obtained.

3.4.2.3 Moisture

Describe the moisture condition of the soil as dry (absence of moisture, dusty, dry to the touch), moist (damp but no visible water, even in interstices) or wet (visible free water, saturated).

3.4.2.4 Maximum Grain Size

Describe the maximum particle size found in the sample in accordance with the information listed below.

- **Sand Size** - If the maximum particle size is a sand size, describe as fine, medium, or coarse.
- **Gravel Size** - If the maximum particle size is a gravel size, describe the diameter of the maximum particle size in inches.
- **Cobble or Boulder Size** - If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle.

For gravel and sand components, describe the range of particle sizes within each component. For example, "about 20% fine to coarse gravel, about 40% fine to coarse sand."

3.4.2.5 Odor

Due to health and safety concerns, NEVER intentionally smell the soil. This could result in exposure to volatile contaminants that may be present in the soil. If, however, an odor is incidentally noticed, it should be described if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation (sometimes a hydrogen sulfide ["rotten egg"] smell). If the odor is unusual (petroleum product, chemical, etc.), it should be described. Organic vapor readings from an OVM or similar instrument should be noted on the field boring log. The project-specific Heath and Safety Plan should then be consulted to determine the appropriate level of protection necessary for the continuation of fieldwork.

3.4.2.6 Cementation

Describe the cementation of intact coarse-grained soils as weak, moderate or strong, in accordance with the criteria listed below.

- **Weak** - Crumbles or breaks with handling or little finger pressure
- **Moderate** - Crumbles or breaks with considerable finger pressure
- **Strong** - Will not crumble or break with finger pressure

The presence of calcium carbonate may be confirmed on the basis of effervescence with dilute hydrochloric acid, HCl, if calcium carbonate or caliche is believed to be present in the soil. Proper health and safety precautions must be followed when mixing, handling, storing, or transporting HCl.

3.4.2.7 Angularity

Describe the angularity of the sand (coarse sizes only), gravel, cobbles and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria listed below.

- **Angular** - Particles have sharp edges and relatively planar sides with unpolished surfaces
- **Subangular** - Particles are similar to angular description but have rounded edges
- **Subrounded** - Particles have nearly plane sides but have well-rounded corners and edges
- **Rounded** - Particles have smoothly curved sides and no edges

A range of angularity may be stated, such as "subrounded to rounded".

3.4.2.8 Structure

Describe the structure of intact soils in accordance with the criteria in Attachment G.

3.4.2.9 Lithology

Describe the primary lithologies (rock or mineral type) of the sand, gravel, cobbles and boulders, if possible. It may be difficult to determine the lithology of fine and medium-grained sand or particles that have undergone alteration.

3.4.2.10 Additional Comments

Additional comments may include the presence of roots or other vegetation, fossils or organic debris, staining, mottling, or oxidation; difficulty in drilling and caving or sloughing of the borehole walls. Also, when drilling in an area known or suspected to contain imported fill material, every effort should be made to identify the contact between fill and native soils. If a soil is suspected to be fill, this should be clearly indicated on the log following the soil description. Stratigraphic units and their contacts should be noted wherever possible.

3.4.3 Additional Boring Log Information

In addition to soil descriptions, there are several other items that should be included on all *soil boring log forms*, included in Attachment F. Information in the log heading should be complete and accurate. The information listed below should be included, at a minimum.

- Boring or monitoring well number
- Project name and job number
- Site name
- Name of individual who logged the boring
- Drilling contractor
- Drill rig type and method of drilling (for example, "CME 75, hollow stem auger")
- Name of drilling company
- Name of driller and helper
- Borehole diameter and drill bit type
- Type of soil sampler (for example, Modified California, continuous core, etc.)
- Time and date that drilling started and finished
- Time and date that the well was completed or the soil boring backfilled, as appropriate
- Method of borehole abandonment, if applicable
- Sketch map of boring or well location with estimated distances to major site features such as property lines or buildings and north arrow

Soil sample information should include the depth interval that was sampled, the blow counts per six inches, the amount of soil recovered and the portion submitted for analysis or testing, if any. The sample identification number may also be noted on the log.

The degree to which soil samples are collected during a field effort depends on the overall scope and purpose of the investigation, which should be clearly defined before the field effort commences. Additional soil samples may need to be collected if, for example, soils are very heterogeneous or unexpected conditions such as perched water zones or zones of contamination are encountered.

If groundwater is encountered during drilling, the depth to water and the time and date of the observation should be recorded. If the first water encountered is a perched zone, the depth, time and date that any additional groundwater zones are encountered should also be recorded. Depth to water after drilling, the measuring point and the date and time of the measurement(s) must be noted. Additional measurements of depth to groundwater, including depth and time, may be beneficial.

4.0 MONITORING WELL DESIGN AND INSTALLATION

4.1 General

This guideline is applicable to the design and installation of permanent monitoring wells. Each monitoring well will be designed to suit the hydrogeologic setting of the site, the type of contaminants to be monitored, the overall purpose of the monitoring program and other site-specific variables. During all phases of well design, attention must be given to clear documentation of the basis for design decisions, the details of well construction and the materials to be used. A Typical Monitoring Well Installation Diagram is provided as Attachment H and a Monitoring Well Construction Form is provided in Attachment I.

4.2 Well Locations

The current scope of work entails installing five monitoring wells. The locations and rationale of these wells are discussed in the SAP Addendum. These wells are located as single wells.

4.3 Well Design

4.3.1 Casing Diameter and Screen Length

Monitoring well casing diameter is dependent on the purpose of the well and the amount and size of downhole equipment that must be accommodated. All of the wells are designed to be multipurpose monitoring wells. Therefore, they will all be constructed with 4-inch or 6-inch diameter PVC well casing.

With the exception of any wells specifically designed for accommodating a pumping test, the screen lengths will be 10 to 20 feet. Any wells that will be screened near the water table will be screened across the water table. Consideration should be given to seasonal fluctuations in water levels when locating the well screen across the top of the water table.

4.3.2 Casing and Screen Materials

The two most commonly used materials are PVC and stainless steel. PVC is inexpensive, widely available, lightweight and easy to work with. Many studies have been conducted concerning the effect of PVC on water quality data. Adsorption of some chlorinated species to PVC was found to be too slow to effect data quality. Because a sample is generally taken shortly after the purging of stagnant water in contact with the casing, the contaminants in the water will have minimal time to be influenced by sorption or leaching effects. Therefore, potential sample bias effects due to interactions with PVC are negligible (Reynolds, et al, 1990). Consequently, monitoring well casings and screens will be constructed of polyvinyl chloride (PVC). Wells less than 500 feet deep will be constructed of schedule 40 PVC, while deeper wells will be constructed of schedule 80 PVC.

The hydraulic efficiency of a well screen depends primarily upon the amount of open area available per unit length of screen. The two screen types commonly used for monitoring wells are machine-slotted and continuous-slot wire-wound. The continuous-slot, wire-wound screen has a greater area per opening per length and diameter than is available with any other screen type. The percentage of open area in continuous-slot screen is often more than twice that provided by standard slotted well screen. The triangular shaped wire makes these screens non-clogging. The monitoring wells installed at the site will be constructed with machine-slotted PVC screens, except ones installed for those constructed as pumping wells for aquifer tests, which may be installed with continuous-slot wire-wound PVC screen.

Additional construction specifications are listed below.

- Threaded, flush-joint casing
- Well caps that are vented to prevent the accumulation of gases and to allow water levels in the well to respond to barometric and hydraulic pressure changes
- Threaded end-caps

4.3.3 Decontamination of Casing and Screen Materials

During the production of PVC casing, a wax layer can develop on the inner wall of the casing; protective coatings may also be added to enhance casing durability. All of these represent potential sources of chemical interference and must be removed with either a laboratory-grade non-phosphate solution or by steam cleaning prior to installation. Factory cleaning of casing and screen in a controlled environment by standard detergent washing, rinsing and air-drying procedures is superior to any cleaning efforts attempted in the field. Factory cleaned and sealed casing and screen that is certified by the supplier will be used if available.

4.3.4 Filter Pack and Well Screen Design

A properly designed monitoring well requires that a well screen be placed opposite the zone to be monitored and be surrounded by materials that are coarser and of greater hydraulic conductivity than the natural formation material. Filter packs are installed to create a permeable envelope around the well screen. The selection of the filter pack grain size should be based on the grain size of the finest layer to be screened.

The typical well construction for a monitoring well in average formation materials includes filter pack on the order of #3 Monterey sand size and 0.020 inch slotted screen. For finer formations, 0.010 inch slotted screen may be used with appropriately graded sand (e.g., 20/40). A configuration similar to this will be used, unless the materials encountered are radically different than expected. The design of wells to be used for pumping during a pumping test is described in Section 10.2.4.

If conditions warrant, filter pack grain size and well screen slot size should be determined by the grain size distribution of the formation material. The filter pack should be designed first. It is recommended to use a filter pack grain size that is three to five times the average (D50) size of the formation materials. D50 will be estimated based on the lithologic description made by the site geologist or hydrogeologist. However, this method may be misleading in coarse, well graded formation materials. Another way to determine filter pack grain size is to take the D30 grain size of the formation materials and multiplying it by a factor of between 3 and 6, with 3 used if the formation is fine and uniform and 6 used if the formation is coarse and non-uniform. For both methods, the uniformity coefficient of the filter pack materials should be as close to 1.0 as possible to minimize particle size segregation during filter pack installation.

The filter pack will extend from the bottom of the well screen to approximately 3 to 5 feet above the top of the screen to account for settlement of the pack material during development and to act as a buffer between the well screen and the annular seal. Filter pack thickness must be sufficient to surround the well screen but thin enough to minimize resistance to the flow of fine-grained formation material and water into the well during development. Consequently, a filter pack thickness of approximately 2 inches will be used.

The materials comprising the filter pack should be as chemically inert as possible. It should be comprised of clean quartz sand or glass beads. Filter pack materials usually come in 100-pound bags; these materials are washed, dried and factory packaged.

The size of well intake openings can only be selected after the filter-pack grain size is specified. The slot size should be such that 90 percent to 100 percent of the filter-pack material is held back by the well screen.

The casing string should be installed in the center of the borehole. This will allow the filter-pack materials to evenly fill the annular space around the screen and ensure that annular seal materials fill the annular space evenly around the casing. Where a dual-tube rig is used, the inner tube of the dual tube will adequately centralize the casing string. For other types of drilling, centralizers will be used to ensure the casing string is positioned in the center of the borehole. Centralizers are typically expandable metal or plastic that attach to the outside of the casing and are adjustable along the length of the casing. Centralizers will be attached immediately above the well screen and at 20 to 50-foot intervals along the casing to the surface.

Methods for filter pack emplacement normally used for monitoring wells include: 1) gravity (free-fall); and 2) tremie pipe. Gravity emplacement is only possible in relatively shallow wells (less than ~50 feet) with an annular space of more than 2 inches where the potential occurrence of bridging is minimized. Bridging can result in the occurrence of large unfilled voids in the filter pack or the failure of filter pack materials to reach their intended depth. Gravity emplacement may also cause filter pack gradation. Additionally, formation materials from the borehole wall can become incorporated into the filter pack, potentially contaminating it.

With the tremie emplacement method, the filter pack is poured or slurried into the annular space adjacent to the well screen through a rigid pipe, usually 1.5 inches in diameter. Initially the pipe is positioned so that its end is at the bottom of the annulus. If the filter pack is being installed in a temporarily cased borehole (e.g., dual-tube percussion) the temporary casing is pulled to expose the screen as the filter-pack material builds up around the well screen. In unconsolidated formations the temporary casing should only be pulled out 1 to 2 feet at a time to prevent caving. In consolidated or well-cemented formations or in cohesive unconsolidated formations, the temporary casing may be raised well above the bottom of the borehole prior to filter pack emplacement. For deep wells and/or nonuniform filter pack materials, the filter pack may be pressure fed through a tremie pipe with a pump. Emplacement will be continuously monitored with a weighted measuring tape accurate to the nearest 0.1 foot to determine when the filter pack has reached the desired height.

4.3.5 Annular Seal

Proper annular seal formulation and placement results in the complete filling of the annular space and envelopes the entire length of the well casing to ensure that no vertical migration can occur within the borehole.

Annular seal materials will include bentonite chips or a high solids (approximately 10%) bentonite grout with a weight in the range of eleven to thirteen pounds per gallon of sealant. The grout will be mixed using the manufacturer's directions. A bentonite seal at least 2 feet thick will be emplaced immediately above the filter pack using a side-discharge tremie pipe. The use of bentonite as a sealing material depends on its efficient hydration following emplacement. Expansion of bentonite in water can be on the order of 8 to 10 times the volume of dry bentonite. This expansion causes the bentonite to provide a tight seal between the casing and the adjacent formation. Bentonite pellets, granules, or chip will be used for this seal. Bentonite pellets expand in water at relatively slow rates, thus reducing the potential for bridging compared to chips, chunks, or granules. If the bentonite seal will be above the saturated zone, several gallons of clean distilled water will be poured down the annulus to begin the hydration process. A minimum of 30 minutes should pass to allow for hydration before additional annular seal materials are placed above the bentonite.

The high solids grout will be mechanically blended in an aboveground rigid container and pumped through a tremie pipe to within a few inches of the bottom of the space to be sealed. This allows the grout to displace groundwater and loose formation materials up the hole. The end of the tremie pipe should always remain in the grout without allowing air spaces. After emplacement, the tremie pipe should be removed immediately. The grout should be emplaced in one continuous mass before initial setting of the cement or before the mixture loses its fluidity.

Cement is a highly alkaline substance (pH from 10 to 12) and introduces the possibility of altering the chemistry of the water it contacts. Thinner slurries may infiltrate an unprotected filter pack. After a borehole annulus is filled with grout a sample of water may be obtained and the pH determined in the field. A pH reading of 12 or higher may indicate an invasion of cement grout into the well.

4.3.6 Surface Completions

Two types of surface completions will be used: aboveground and flush-mounted. Aboveground completions will be used wherever practical. Flush mounted completions will be used anywhere there may be vehicle traffic or where low visibility is preferred. The primary purpose of either type of completion is to prevent surface runoff from entering and infiltrating down the annulus of the well and to protect the well from accidental damage or vandalism. The surface seal may be an extension of the annular seal installed above the filter pack, or a separate seal emplaced atop the annular seal.

For aboveground completions, a protective steel casing fitted with a locking cover will be set into the uncured cement surface seal. Three to four guard posts (bollards) will be spaced around each well with above ground completions to afford additional protection.

In a flush-mount surface completion, a water-tight monitoring well Christy box or its equivalent will be set into the cement surface seal before it has cured. This type of completion is used in high-traffic areas. A low, gently sloping mound of cement will discourage surface runoff. A locking well cap will be used to secure the inner well casing.

4.3.7 Summary of Well Design

In summary, the filter pack and well design criteria for the investigations are listed below.

- PVC screen and casing
- Schedule 40 casing for wells less than 500 feet deep
- Schedule 80 casing for wells greater than 500 feet deep
- 0.010 or 0.020-inch machine slotted screen
- 2-inch to 4-inch diameter casing

- Threaded flush joint casing and end-caps
- Centralizers in uncased holes
- Sand appropriately graded for the well screen for filter packs up to 3 to 5 feet above the top of the screened interval
- Bentonite plug at least 2 feet thick on top of filter pack
- Annular seal to the surface to consist of bentonite or neat cement
- Both filter pack and annular seal are to be emplaced using a tremie pipe
- Surface completions will be aboveground stand-pipes with bollards unless in a vehicle traffic right-of-way of area where low visibility is preferred

5.0 PIEZOMETER INSTALLATION

Piezometers are typically installed at investigation sites where permanent groundwater monitoring wells are not required or are not feasible. Piezometers are primarily used for groundwater elevation studies. Piezometers differ from permanent monitoring wells mainly in construction and development standards. However, like permanent monitoring wells, piezometers will be designed to suit the hydrogeologic setting, the types of contaminants to be monitored, the overall purpose of the monitoring program, and other site-specific variables. Clear documentation of design parameters, construction details, and materials used will be maintained. During installation of piezometers, care will be taken to ensure that they do not serve as conduits for surface contaminants to the subsurface. Therefore, surface completions will follow essentially the same standards as outlined for monitoring wells.

5.1 Basic Installation and Operation of Piezometers

A piezometer is essentially a device used for the measurement of hydraulic head. A piezometer must be sealed along its length, must be open to groundwater flow at the bottom, and be open to the atmosphere at the top. The intake is usually a section of slotted pipe or a commercially available well point. In either case, the intake is designed to allow the inflow of water but not of the sand grains or clay particles that make up the formation. A simple standpipe piezometer may be replaced in some applications by more complex designs utilizing pressure transducers, pneumatic devices, and electronic components.

Piezometers are installed using either direct-push methods or installed through a soil boring. With the use of direct-push methods, the piezometer pipe is attached to the push rods and driven to depth using a hydraulic ram. With use of a drill rig, the pipe is attached to standard soil sampling drill rods and driven to depth using either a standard 140-pound hammer, or hydraulically advanced into the water-bearing zone. Blow counts during advancement of the sampler should not exceed 30 per 6 inches. Piezometers can also be constructed in auger strings within a boring.

Unless otherwise specified in project-specific work plans, piezometers will be completed as naturally developed wells with the formation materials allowed to collapse around the screen. As previously described for monitoring wells, screen slot sizes will be based on grain-size distribution. Surface completions will be constructed in a similar manner as for monitoring wells. However, the protective outer PVC casing will not be installed. The piezometer will instead be fitted with a PVC end cap.

Piezometers will be constructed using one of three common methods:

1. Using the pull-back method

2. Driving the well point beyond the end of the casing into the formation below

3. Construction within drill pipes or augers

Pull-Back Method: In the pull-back method for piezometer installation, the casing is first set to the desired depth. A packer is then threaded to the top of the well point or riser pipe and lowered through the casing. After the well point has been lowered through the casing, the casing is pulled back to expose the screen to the water-bearing sediment. Drill tools (drill stem or driving bar) may be placed on the well point to hold it down as the casing is pulled back. Alternatively, some well points are manufactured with a drive plate mounted just above the point. The driving force is directed at the point, and the screen is pulled into place. However, care should be taken when using this technique as inside driving may cause severe damage to the bottom of the screen. All points to be driven from the inside should be identified as such when ordered from the manufacturer. Two-inch well points can be set in 4-inch diameter wells using the pull-back method.

Driven Well Point: Occasionally the pull-back method cannot be used because the friction on the pipe is so great that the force required to move the pipe might break it. In this case, a well point can be driven beyond the end of the casing into the sand formation below. All the sediment in the casing is removed to prevent the well point from becoming sand-locked inside the pipe. If the sediment tends to heave, the casing is kept full of water while the screen is set (any water used should be from an approved source and complete records of quantities used should be maintained). A self-sealing packer is attached to the well point, and the well point is dropped through the casing. A driving bar, drill stem, or other similar tool is lowered to the top of the packer and alternately raised and dropped to drive the well point out the bottom of the casing. Careful measurements must be made so the driller knows when the screen has been driven to the correct depth. A riser pipe may be used for this purpose.

Construction within Drill Pipe or Auger: Two-inch well points can be easily set through drill pipes or hollow stem augers once the pipes/auger-flight assembly has reached the desired depth. The screen is attached directly to the casing, and the string is lowered inside the pipes/augers to the bottom of the borehole. The pipes/auger flights are then pulled back to expose the screen and casing. This method is particularly suitable in shallow, caving formations.

6.0 WELL DEVELOPMENT

The goal of monitoring well development is to remove fines and drilling fluid residue from the gravel pack and the natural formation in the vicinity of the screened interval, this will assure good communication between the aquifer and the well. The result of well development is assurance that a sample collected will be a true representative of the quality of water moving through the formation.

The well development process is composed of: (1) the application of sufficient energy in a monitoring well to create groundwater flow reversals (surging) in and out of the well and the gravel pack to release and draw fines into the well; and (2) pumping or bailing to draw drilling fluids out of the borehole and adjacent natural formation along with fines that have been surged into the well.

6.1 General

The following general guidelines are applicable to well development regardless of method.

6.1.1 Decontamination

It is essential that every effort be made to avoid outside contamination and the cross-contamination of monitoring wells. This can accomplished by ensuring that all equipment is clean prior to being introduced into a well. Before use and between each site, all equipment and other non-sampling equipment will be decontaminated with high-pressure steam or scrubbed with a non-phosphate detergent and rinsed with water from an approved water source. If appropriate, equipment will be covered in plastic to protect it from the elements.

6.1.2 Documentation

A critical part of monitoring well development is recording of significant details and events; a *Well Development Record* is provided in Attachment K. Listed are some important details to document.

- Well identification number
- Installation date
- Date and time of development
- Quantity of drilling fluid lost during well installation
- Measured well depth (pre-development and post-development)
- Water level
- Height of water column
- Pumping rate and water level draw down (if applicable)
- Recharge rate (poor, good, excellent)
- Periodic parameter readings

- Sample observations
- Type of equipment used
- Total amount of water removed
- Completion time

6.1.3 Well Purging

The total volume of water purged during the development process will be based on two factors: (1) indicator parameters and (2) minimum purge volume.

6.1.3.1 Indicator Parameters

During the development process, the indicator parameters pH, temperature, electrical conductivity and turbidity will be measured. The parameters pH, temperature and electrical conductivity will be measured with a field meter while turbidity will be described qualitatively. Other observations of the water, such as color and odor, will also be recorded. Measurement of the indicator parameters will be taken at the beginning and end of the development process and at least once every ½-casing-volume with a minimum of 4 measurements. Once the minimum required volume is reached, as described in Section 6.1.3.2, purging will continue until three consecutive measurements of the stabilization parameters meet the stabilization requirements shown below.

pH	± 0.2 units	
Conductivity	± 3% of span	(i.e., ± 0.03 for span of 0 to 1 mS/cm)
Temperature	± 1° C	
Turbidity	± 10%	

However, if the indicator parameters have stabilized, but there are still significant changes in color or some other qualitative characteristic, purging will continue until it has stabilized, if practical.

6.1.3.2 Purge Volume

Before the development process begins, the minimum number of gallons to be removed will be calculated. The minimum number of gallons to purge will be equal to three casing volumes or one purge volume (described below), whichever is larger.

Information needed to calculate purge volume is listed below.

1. Total depth of well (TD)
2. Measured static water level (WL)

3. Screen length (SL)
4. Well casing inner diameter (ID)
5. Borehole Diameter (BD)
6. Number of gallons of water used during well drilling/construction
7. If the standing water column (SC) is longer then the screen length, you will need to note how many feet of filter pack was installed above the screen.

Calculating one well volume:

- To calculate standing water column (SC), TD - WL = SC
- Use a well volume chart to find a multiplier in the "gallons per foot" column that coincides with the wells ID. This volume chart is located in Attachment K.
- SC x ID multiplier = gallons of water in one well volume

Calculating one annulus volume (2 Options):

Option 1, if SC is shorter then the screen length

- Portion of saturated annulus = SC
- Use a volume chart to find a multiplier in the "Gallons per foot" column that coincides with the wells BD
- BD multiplier - ID multiplier = annulus multiplier
- Feet of saturated annulus x annulus multiplier x 30% (assumed porosity) = gallons of water in one annulus volume

Option 2, if SC is longer then the screen length

- Portion of saturated annulus is = to the screen length + the number of feet of sand above the top of the screen
- Use a volume chart to find a multiplier in the "Gallons per foot" column that coincides with the wells BD
- BD multiplier - ID multiplier = annulus multiplier
- Feet of saturated annulus x annulus multiplier x 30% (assumed porosity) = gallons of water in one annulus volume

Calculating the minimum gallons to be removed: well volume + annulus volume + number of gallons lost during well drilling/construction = one purge volume

Example:

You are to develop a 4-inch well. From the Well Construction Diagram you note the borehole diameter was 11 inches, the screen is 15 feet long and the driller used 75 gallons of water during well construction. With a water level indicator you measure the static water level at 59.45 feet and with a well tagger you measure the well depth at 71.21 feet.

Record in log book: TD = 71.25'
WL = 59.45'

TD -WL = SC
Log book: SC = 11.8'

From a Volume chart, the "gallons per foot" multiplier for a 4-inch well is 0.653 and 11.8 x 0.653 = 7.71 (gallons of water in one well volume).

Log book, One well vol. = 7.71 gallons

From a Volume chart, the "gallons per foot" for an 11-inch borehole is 4.937. Therefore, 4.937(BD multiplier) - 0.653(ID multiplier) = 4.284(annulus multiplier). And, 11.8 x 4.284 x 30% = 15.17 (gallons of water in one annulus volume).

Log book, One annulus vol. = 15.17 gallons
Drilling fluid lost = 75 gallons

7.71(one well volume) + 15.17(one annulus volume) + 75(fluid lost) = 97.88 gallons (one purge volume). A minimum of 3 well volumes must be removed during development. Additional water may need to be purged to allow the parameters to stabilize and the water to clear up.

Log book, One purge vol. = 97.88 gallons
97.88 x 3 = 293.64 (minimum number of gallons to be purged).
Log book, Min. gal. to be purged = 293.64 gallons

6.2 Well Development

Development will be accomplished using surge and bail/pump. In relatively clean and permeable formations where water flows freely into the borehole, bailing, surging and pumping is an effective development technique. First, the bottom of well will be tagged to measure the amount of sand/silt before and after surging that may be present at the bottom of the well. Then a bailer will be lowered down the well to clean out any fines that have settled on the bottom of the well. Then a surge block, slightly smaller than the inside diameter of the well casing, will be used to agitate the water, causing it to move in and out of the screen, thus drawing in fines from the gravel pack and surrounding formation and breaking up any bridges that may have occurred during the placement of the gravel pack. After surging for a few minutes (depending on the height of the water column and length of screen), the bailer will then be lowered again to clean out any fines that were drawn into the casing as a result of surging. This surge/bail technique will continue until minimal fines are being pulled out with the bailer. A submersible pump will then be lowered down the well. Pumping will begin at the top of the saturated portion of the screened interval to prevent sand locking of the pump. The pump will be lowered at intervals of 5 feet or less until the pump is resting approximately 1 foot off the bottom of the casing. The water level will be monitored continuously during the first few minutes of pumping so as not to draw the water level below the pump intake and break the suction. The discharge flow rate will be increased (if possible) until the well is pumping at its maximum yield without draw down beneath the pump.

Developing low-yield wells is a very lengthy process. If development exceeds five hours, the remaining development will be done in stages (demobilize and remobilize), not to exceed three casing volumes or two return trips to the well. For wells installed in clay or fine-grained silt, the method of development will be bailing only. Surging of such wells has been found to substantially increase the turbidity of the water and does not significantly improve hydraulic well response. These wells will be bailed dry and a record kept on the time it takes for the well to recharge 80 percent.

A Well Development Record is provided in Attachment J.

7.0 AQUIFER TESTING

Determining the hydraulic properties of an aquifer is a fundamental component of the site characterization process. This section details aquifer test methods that are commonly implemented to help characterize an aquifer, and evaluate the performance characteristics of a monitoring well.

Aquifer parameters can be determined by employing either ex-situ or in-situ methods. Ex-situ methods involve collecting samples of the aquifer material and testing them in a geotechnical lab. In-situ methods involve determining the hydraulic characteristics of the aquifer by applying a stress to the aquifer and recording the response to that stress over time. In-situ methods are generally considered more representative of aquifer conditions than ex-situ (laboratory) soil permeability testing. As a result, this SOP only describes in-situ aquifer testing. Data resulting from these tests can be used in standard well flow equations to determine the hydraulic parameters of the aquifer and the monitoring/extraction well in which the tests are performed.

Each aquifer test method has certain applications, effort requirements, costs, risks, and limitations, and will be evaluated based on the project goals, design requirements, long-term planning, budget, schedule, and regulatory concerns. In addition, aquifer testing may be conducted in several phases involving one or more of the above methods. This iterative approach may be very effective in that the aquifer-testing program can be tailored to meet the project needs as the site characterization or basin study evolves.

Aquifer tests are typically conducted during the site investigation, although they may also be performed at any phase of an investigation. A great deal of care will be given to data collection methods and data analysis for aquifer tests, as the findings will subsequently be used for long-term resource planning, engineering design, and capitol expenditures. The findings from an aquifer testing program can ultimately be used for several important purposes, including the following:

- Development of the site conceptual hydrogeologic model. Aquifer testing provides the mechanism to quantify and incorporate soil heterogeneity and hydraulic anisotropy into the conceptual model

- Development of analytical groundwater flow solutions (models) such as determination of a groundwater flow velocity

- Evaluation of contaminant fate and transport mechanisms associated with advection

- Generation of parametric data for numerical groundwater flow models and associated solute transport models

- Development of groundwater extraction scenarios for hydraulic containment, collection of contaminants, and aquifer restoration

- Wellhead protection studies (determination of the zone of influence and zone of contribution for production wells) and other groundwater basin studies.

7.1 Definitions

Various physical properties and hydraulic parameters of aquifers and aquitards are important in describing groundwater flow, and are therefore significant in aquifer testing studies. A thorough understanding of the hydraulic principles involved in aquifer testing is an essential component of aquifer analysis. A brief definition of terms that are used in this section are provided below:

Bailing Line: A line used for rapidly lowering and raising the slug into the water column. Deep wells may require the use of the winch on a drill rig.

Darcy's Law: States that the rate of flow through a porous medium is proportional to the loss of head, and inversely proportional to the length of the flow path, or

(eq. 1) $v = K(dh/dl)$

Where:

v = Q/A, which is the specific discharge, also known as the Darcy velocity or Darcy flux, (length/time),

Q = the volume rate of flow (length^3/time),

A = the cross sectional area normal to flow direction (length^2),

dh/dl = describes the aquifer hydraulic gradient (length/length) and,

K = describes the hydraulic conductivity of the aquifer.

Equation 1 may be rewritten as:

(eq. 2) $Q = K(dh/dl)A$

It should be noted that the specific discharge is in velocity units of length/time. It is important to also note that this is a macroscopic concept, and must be differentiated from microscopic (real) flow velocities, which consider the porosity of the medium, as:

(eq. 3) $$v = \frac{K(dh/dl)}{n}$$

where "n" is the effective porosity of the media.

Data Logger: A small field computer capable of recording a wide range of physical measurements such as pressures, temperatures, electrical conductivities, and flow. For aquifer analysis, pressure is generally the parameter of interest (feet of water in the well). The data logger converts the pressure value sent by the transducer into feet of water above the transducer, and records the values in its memory. The data can then be transferred from the logger to a personal computer via a standard RS-232 port.

Each transducer has specific parameters that must be input to the data logger to make the appropriate conversions from pressure units to feet. It is extremely important that field personnel operating a data logger be properly trained on the use of the instrumentation to ensure proper collection of test data.

Common data logger models are the Hermit 3000 (8-channels plus an internal barometer, very user friendly) and Hermit 2000 (8-channels, less user friendly). The Hermit 3000 data logger also contains a RS-422 communication port.

Drawdown: The amount of water level decline in a well and aquifer due to pumping. Usually measured and reported in terms of feet of drawdown relative to static (non-pumping) conditions ('s' by convention).

Electric Submersible Pump: A pumping device capable of pumping for extended periods of time at a constant discharge rate. Discharge pipe or hose should be fitted with a valve to provide the ability to adjust flow. Adjusting the discharge rate by adjusting the speed of the pump is less desirable than the use of a valve. An exception is the variable-speed 2-inch-OD Grundfos submersible pumps, which are designed for adjustable speed (flow) settings. A shroud is recommended if a 2-inch pump is used in a 4-inch or greater diameter well to ensure long-term cooling of the pump motor. The pump will require a reliable power source.

Flow Gauge: An in-line, "turbine type" flow meter is recommended for most moderate to high flow-rate applications. Other means of gauging flow include the use of calibrated orifice weirs or an orifice bucket. For low flow applications, a container and stopwatch method may be suitable. The container method requires measuring the time it takes to fill a container of known volume, such as a 5-gallon bucket or 55-gallon drum. The flow gauging method should be accurate to +/- 5 percent.

Hydraulic Conductivity: This property is a constant of proportionality that describes fluid flow through a porous media (see Darcy's Law, above). Hydraulic conductivity ("K" by convention) is a function of the permeability of the media and of the physical properties of the fluid. Hydraulic conductivity has the units of length/time. In a normal groundwater setting, where the physical properties of the water are considered relatively constant, hydraulic conductivity can be considered a function of the porous media.

For this reason, the terms permeability and hydraulic conductivity are often used interchangeably for groundwater settings. Because hydraulic conductivity varies over 13 orders of magnitude for earth materials (Freeze and Cherry, 1979), order-of-magnitude approximations are generally considered appropriate for evaluation of aquifer properties.

Potentiometric Surface: An imaginary surface connecting points to which water would rise in cased wells from a given point in an aquifer (Lohman, 1979). It may be above or below the ground surface. The water table is a particular potentiometric surface for unconfined aquifers. "Potentiometric" is preferable to the term "piezometric" used by many in the past.

Pressure Transducer: A device installed in the well below the water surface that is capable of continuously providing very accurate water level measurements. The transducer is connected to a continuous data logger (described above). Transducers are available in different pressure (and accuracy) ranges. The transducers should never be lowered into a water column below the operating pressure range of the transducer. Higher pressure range transducers are less accurate than lower pressure range transducers. As a rule, a multiplier of 2.3 can be used to estimate the maximum total amount of water above a transducer (i.e., a 10-psi transducer can have 23 feet of water above, a 50-psi transducer can have 106 feet of water above, etc.). For example, if a 10-psi transducer is installed at the bottom of the well with 100 feet of water above it, it will no longer function properly, and must be returned to the manufacturer for recalibration.

Please note, the transducer only needs to record the change in water levels, and therefore should be installed immediately below the lowest depth expected. A 10-psi transducer is capable of measuring up to 23 feet of change in water levels to 0.01 foot accuracy, and is therefore the recommended transducer for slug tests. Transducers will operate improperly if lowered into sediment, and therefore should never be lowered to the bottom of the well. The target depth of the transducer should be identified prior to lowering into the well, and then the transducer cable should be marked with duct tape to ensure that the transducer is not lowered too deep.

Residual Drawdown: Once a pump is shut off during a pumping test, water levels in pumping wells, observation wells, or piezometers will rise. This rise in total head results from the principle of superposition, and is commonly known as residual drawdown ('s' by convention). It is expressed as the difference between the static water level and the water level at time t' after the cessation of pumping.

Slug: A solid pipe used to displace water by insertion or withdrawal from a well. Bailers may also be used for slug withdrawal only. The slug volume should be maximized based on field conditions. Different length slugs, capable of threading together, should be brought to the field to provide flexibility to the program. A typical slug used for a 2-inch-diameter monitoring well may be 1.5 inches in diameter and 6 to 10 feet in length. The volume of the slug used for each test must be recorded in the field notes.

Specific Capacity: The specific capacity is defined as the discharge rate per unit length of drawdown for a pumping well. Typically expressed in gallons per minute per foot of drawdown (gpm/ft).

Specific Yield: The specific yield is the volume of water released by gravity drainage from an unconfined aquifer from storage per unit surface area of the aquifer per unit decline in the watertable. Specific yield is also known as unconfined storativity, effective porosity, or drainable pore space. Specific yield is unitless and typically ranges from 0.01 to 0.3 (Kruseman and de Ridder, 1991).

Static Water Level: The non-pumping, stabilized water level in a cased well or piezometer. Usually recorded in the field as depth to water below a datum such as the top of casing. This term is usually reported in feet above mean sea level.

Storativity: The storativity of a confined aquifer is the volume of water released from storage per unit surface area per unit change in head. For confined aquifers, stored water is released via aquifer compression and expansion of water. In an unconfined (watertable) aquifer, the storativity is equivalent to the specific yield and is also known as the storage coefficient. Storativity is dimensionless and typically ranges from 5×10^{-5} to 5×10^{-3} (Kruseman and de Ridder, 1991).

Total Head: The sum of the elevation head, the pressure head, and the velocity head at any given point in an aquifer.

Transmissivity: The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient (Fetter, 1980). This term ("T" by convention) is simply the product of the hydraulic conductivity (K) and the aquifer thickness ("b" by convention).

(eq. 4) $$T = Kb$$

Transmissivity may vary significantly due to spatial variations in both the thickness and conductivity of the aquifer. Transmissivity carries the units $\text{length}^2/\text{time}$. For aquifers, b is the thickness of the confined aquifer. For unconfined aquifers, b is the thickness of the saturated portion of the aquifer.

Water Level Indicator: A device used to measure static water levels. An electrical conductivity-based water level indicator capable of measuring to 0.01 foot accuracy is required for all measurements.

7.2 Aquifer Testing Methods

All aquifer test methods, such as slug tests, pumping tests, and recovery tests, have unique advantages and limitations. This section describes the principles, methodology, and staffing requirements for slug testing and pneumatic slug testing. Several methods are described here, paying attention to the limitations of each.

7.2.1 Slug Testing

Principle: Slug testing involves either introducing or removing a "slug" of known volume into or from a well and recording the water level changes that result. The rate of recovery observed in the well is a function of the hydraulic properties of the aquifer and of the well itself. The transmissivity of the aquifer can then be estimated using appropriate well-flow equations.

Assumptions and Limitations of Slug Testing: Slug tests stress only a small portion of the aquifer adjacent to the well, and therefore, slug tests are incapable of evaluating hydrogeologic boundary conditions, hydraulic anisotropy, storage coefficients, and pumping characteristics of the well. However, slug tests commonly provide a cost-effective means of gathering "point" transmissivities across a screen interval. Slug tests are commonly considered as a first step in characterizing an aquifer because of the relative low cost and effort requirements. Additionally, slug tests do not generate large volumes of groundwater, and therefore often used to initially characterize water-bearing zones beneath hazardous waste sites, where disposal options of contaminated groundwater may be limited or costly.

It is important to note that slug tests do not provide adequate information regarding the hydraulic characteristics of a pumping well. Additionally, because of the small stress applied to the aquifer, data may be influenced by drilling methods (skin effects), well construction, and development procedures. Slug tests alone cannot provide accurate information regarding boundary conditions, anisotropy, or storage coefficient data, and are therefore not useful for predicting steady-state drawdowns resulting from any given hypothetical pumping scenario. The development of long-term groundwater extraction scenarios, such as in most modeling studies, should therefore not be based solely on slug test data, but require more sophisticated pumping tests, if feasible.

Falling Head Slug Tests: Falling head slug testing involves the insertion of a slug into the well that is screened below the water table. If a slug is rapidly inserted into the water column in a well, it will instantaneously raise the water column in the well. The amount of head change is defined as the instantaneous head (H_O). The water column will then "fall" to the static water level at a rate that is controlled by the hydraulic characteristics of the water-bearing formation and of the well itself. Falling head slug tests are not appropriate for water table wells (i.e., wells in which part of the screen is unsaturated and the screened interval is within the first water encountered).

Rising Head Slug Tests: Rising head slug testing requires submerging the slug under water in a well, and allowing the water level to stabilize to static conditions. The slug is then rapidly withdrawn from the well. After the slug is withdrawn from the well, the instantaneous water level will be at a level that is lower than the static water level. The rate at which the water level recovers to static condition is a function of the aquifer properties and of the well itself.

Both falling and rising head methods can be used in series during a slug testing program. The slug insertion method may be followed by the slug withdrawal with relative ease. However, if a slug insertion method is chosen for unconfined aquifers, groundwater will be displaced above the water table and into the unsaturated sand filter pack of the well and the formation itself. It should be noted that the hydraulic conductivity of the soils overlying the water-bearing zone may differ from those of the aquifer. Additionally, hydraulic conductivity of unsaturated soils varies as a function of moisture content. For these reasons, a slug withdrawal method is generally considered advantageous to slug insertion in unconfined or semiconfined aquifers due to two-phase (air and water) flow. A good rule-of-thumb is that if the static water level is within the screened interval of the well being tested, a slug withdrawal method should be chosen for aquifer analysis.

Selection of the Slug: Several different types of slugs may be used for the test, including:

- Solid pipe fitted with an eye bolt at one end to affix a bailing line
- Stainless steel or Teflon bailers
- A slug of water of known volume.

Introduction of a slug of water (usually distilled, organic-free water) may not be feasible due to regulatory restrictions. In addition, it is generally considered infeasible to "instantaneously" withdraw a slug of water using a pump. The withdrawal of a slug of water is limited to the use of bailers. The most common slug test involves the use of solid pipes (either slug insertion or withdrawal methods), or the use of bailers (slug withdrawal only).

An additional slug testing method involves applying a pressure or vacuum to the well head and measuring changes in water levels that result following the removal of the pressure. This method requires specialized well fittings, generators, and compressors. Details of this method are provided in Kruseman and de Ridder (1991) (Oscillation Method, p.238), and are not included in this SOP.

The remainder of this section focuses on slug tests conducted using a solid slug, although the general methods for slug tests analyses do not vary significantly if other types of slugs are used for the test.

A large slug will stress the aquifer to a greater degree than a small slug, and therefore the size of the slug should be maximized based on field conditions. Three-foot Teflon bailers or sections of solid pipe can be threaded together to optimize slug volume. The size of the slug is limited only by the standing water column in the well and physical limitations in one's ability to instantaneously insert or withdraw the slug.

Slug Insertion (Falling Head) Test Methods: The procedures outlined below will be followed while conducting falling head slug tests.

1. Remove the well head expansion cap and allow the well to equilibrate to atmospheric conditions.

2. Record the static water level using a conductivity-based water level indicator. Measure the total depth of the well. Note: potential sediment at the bottom may have decreased the total depth value recorded during construction.

3. Determine the appropriate depth of 10-psi transducer. This will generally be between 10 and 20 feet below the static water level, or above potential sediment at the bottom of shallow wells. Affix duct tape to transducer cable to indicate the target depth below top of casing.

4. Lower a 10-psi transducer to the target depth. The transducer and transducer cable must hang plumb in the well to minimize entanglement with the slug. Duct-tape the transducer cable to an immovable object, such as the top of casing. Allow the well to equilibrate to static water levels.

5. Connect the pressure transducer to a continuous data recorder. Input the required transducer parameters and other test parameters in the data logger. The data logger will need to be referenced to the top of casing (TOC) or surface (static water level datum). It is recommended that it is "zeroed" to the static water level, and therefore measured water level changes will be relative to static water level. Water levels above static water levels will be recorded as positive, and water levels below static will be recorded as negative values. The slug test requires only measuring the change in head associated with slug insertion or withdrawal. The "surface mode" is therefore the desired data logger "mode" for slug testing**.** “TOC mode” refers to measuring the absolute value (i.e., total head) of the water level relative to the TOC datum. This is an unnecessary step that may introduce error in the field, and is therefore not recommended for slug testing. An accurate record of all input parameters and field observations will be included in the field logbook.

6. "Zero" the pressure transducer/data logger to static water levels. Confirm static levels with a water level indicator. The data logger should be set to begin the test in the "immediate" mode (i.e., no time delay). The data logger will be set to record water levels as frequently as possible (i.e., using the "log" mode and default settings).

7. Affix a bailing line to the slug. To accurately complete the test, the slug will be completely submerged in the well. Record the volume of the slug in the field log. Determine the total depth required to submerse the slug. A piece of duct tape may be

used to identify the desired length of the bailing line. The slug will be lowered to a "ready" position immediately above the static water level. The slug must not be tangled with the transducer cable.

8. ***Critical step.*** On a pre-determined count, ***lower*** the slug rapidly (but gently) to total submersion and trigger the data logger to begin recording water levels. The slug should remain motionless once it has been lowered into the well. The bailing line for the slug will be tied to an immovable object (tailgate of truck, etc.) once the slug is submerged. Allow the data logger to complete it's logarithmic data recording cycle (approximately 2-3 minutes) prior to confirming water levels with a water level indicator. Wells screened within low to moderately transmissive aquifers may require from 30 seconds to several minutes or even hours to recover to static water levels. If the well recovers within a few seconds, it is likely that the well is screened within a moderate to high transmissivity zone, and therefore the slug test method is likely not an appropriate test method for the determination of aquifer properties.

9. The slug injection test is completed when the water level recovers to static water levels. In many instances, the final few tenths of a foot of recovery may require a significant amount of time (hours). The field team will use their best judgement regarding when to terminate the test. It should be noted that for nearly all methods of data analysis, the last data points are equally significant as the initial data points. The validity of the tests will not be compromised due to impatience of field team members. In many cases, the team can be setting up the next test on a different well while the previous well completes its recovery.

10. Once the well has equilibrated to at least 90 to 95 percent of static water level, the test can be terminated by stopping the data logger. However, at this time, it would be advantageous to initiate a slug withdrawal test (see item #6 below). This may be accomplished by either "stopping" the insertion test, or "stepping" the test by using the "Step" function of the data logger. The original input parameters remain unchanged if you choose to use the "Step" function or stop and start function. Both methods involve restarting the "log cycle" for the data logger (highly desirable for the early time data). An accurate record of test numbers and step numbers will be maintained in the field logbook.

Slug Withdrawal (Rising Head) Test Methods: Follow steps 1 through 5 as described above for the falling head slug test. Steps 6 through 8, below, describe the slug withdrawal test method.

6. Lower the slug into the water column so the slug is fully submerged. For this test, tie the slug bailing line to an immovable object and allow the slug to remain motionless in the well. Ensure that the slug is not entangled with the transducer or transducer cable.

7. Allow the well to equilibrate to the static water level. The well recovers most quickly if a bailer is used for the slug. A solid pipe slug requires a longer period of time to recover. Verify that the well has equilibrated to static water level with a water level indicator.

8. ***Critical step.*** On a pre-determined count, one person will rapidly (and in a fluid motion) ***retrieve*** the slug from the well while the second person simultaneously triggers the data logger to begin recording water levels. Remove the slug from the well while making sure not to disturb the transducer cable. As stated above, allow the data logger to complete it's logarithmic data recording cycle (approximately 2-3 minutes) prior to confirming water levels with a water level indicator. Wells screened within low to moderately transmissive aquifers may require from 30 seconds to several minutes or hours to recover to static water levels. If the well recovers within a few seconds, it is likely that the well is screened within a moderate to high transmissivity zone, and therefore the slug test method is likely not an appropriate test method for determination of aquifer properties.

Slug Withdrawal (Pneumatic) Test Methods:

1. Measure the static water level.

2. Determine the distance from static water level to the top of the screen. (The amount of downward pressure imparted by the air must not exceed this distance.).

3. Install the pneumatic slug testing well assembly. This includes;
   a. A quick-release ball valve at the top of the unit is the same diameter as the well or larger
   b. A manual air gauge that monitors the pressure injected into the well head and is preferably graduated in inches or centimeters of water for use
   c. An air injection port that can accommodate standard air tools
   d. A base that can accommodate either two-inch or four-inch wells and has an easy-to-install airtight seal

4. Orient the ball valve such that upon opening the valve, air will flow straight through the entire unit without turning any corners.

5. Insert the probe port so that it will not interfere with the ball valve and allows for effective air sealing around the transducer cable

6. Program the transducer to desired settings

7. Pressurize the well to a pressure equivalent that is four to eight feet of water, but do not exceed the previously determined maximum.

8. Wait for the pressure gauge on the well head to stabilize; when the aquifer is approaching equilibration and the test may commence.

9. Start the test on the instrument, wait for a few seconds, and then open the ball valve at the well head and allow the air to escape from the well.

10. Monitor the water level as it rises. The test is complete when the water level has risen to the approximate original static water level.

11. Once equilibrium was reached, the data logger was started to collect a few static data points prior to opening the ball valve and releasing the slug. After the slug is released, the transducer will record the water-level recovery.

12. The final segment of the curve will be used to analyze the data and calculate the hydraulic conductivity of the aquifer

It is recommended that two slug tests be conducted for each well for data verification purposes. Most data loggers allow the user to view the data or download the data to a field personal computer. Data will be reviewed in the field following completion of the test to ensure that the transducers and data logger are functioning properly.

The initial head values (H_O) which result from instantaneous withdrawal or injection of the slug will be evaluated against the maximum theoretical drawdown. This can easily be completed by calculating the volume of the slug and converting volume of the slug to volume of water in a well. The well volume can then be converted to feet of water in the well column. An example calculation is provided below:

Hypothetical slug size:

0.75-inch outer diameter (OD) x 60-inch length = 106.05 $in.^3$

Conversion to gallons:

106.05 $in.^3$ x (0.004329 gallons/$in.^3$) = 0.46 gallons

Conversion to feet (assumes a 2-inch inner diameter (ID) well):

0.46 gallons x (1 foot/0.16 gallons) = 2.88 feet

Therefore, using a slug that is 0.75 inches in diameter and 60 inches (5 feet) in length, the maximum anticipated change in water level with respect to static levels (H_O) would be 2.88 feet. This should be evaluated against the maximum head change observed in the field. Significantly different (greater than 20-30 percent) values may indicate that the transducers or data loggers are not functioning properly. Other possibilities are that the slug is not being inserted or withdrawn rapidly enough, or that the timing between the "trigger" operator and the "slug" operator is off. These factors will be evaluated and resolved prior to conducting additional slug tests.

Data loggers generally have sufficient memory to record an entire day of slug testing. The data will be downloaded daily to minimize the risk of loss of data. An electronic and hard copy will be stored.

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ATTACHMENTS

ATTACHMENT A

GLOSSARY OF TERMS

Absorption - The penetration or apparent disappearance of molecules or ions of one or more substances into the interior of a solid or liquid.

Adsorption - The process by which atoms, ions, or molecules are held to the surface of a material through ion-exchange processes.

Annular Sealant - Material used to provide a positive seal between the borehole and the casing of the well. Annular sealants should be impermeable and resistant to chemical or physical deterioration.

Annular Space - The space between the borehole wall and the well casing, or the space between a casing pipe and a liner pipe.

Annulus - The gap between the well and borehole where the sand, seal and grout are installed.

Aquifer - A geologic formation, group of formations, or part of a formation that can yield water to a well or a spring.

Backwashing - A method of filter pack emplacement whereby the filter pack material is allowed to fall freely through the annulus while clean fresh water is simultaneously pumped down the casing.

Bentonite - Hydrous aluminum silicate available in powder, granular, or pellet form. It is used to provide a tight seal between the well casing and the borehole.

Bailer - A cylindrical tool designed to remove material, both solid and liquid, from a well or borehole. A valve at the bottom of the bailer retains the material in the bailer. The three types of bailers are flat-valve bailer, a dart-valve bailer and the sand pump with rod plunger.

Blow Counts - Number of hammer blows needed to advance a split spoon sampler. Blow counts are usually counted in 6-inch increments.

Borehole - The hole created by drilling through the subsurface.

Bridge - A wedge or build up of sand that occurs when the driller is pouring the sand pack around the screened interval, thus leaving a gap or "open zone" where the natural formation could possibly clog the screen. Also the development of gaps or obstructions in either grout or filter pack materials during emplacement.

Cone Penetrometer - An instrument used to identify the underground conditions by measuring the differences in the resistance and other physical parameters of the strata. The cone penetrometer consists of a conical point attached to a drive rod of smaller diameter. Penetration of the cone into the formation forces the soil aside, creating a complex shear failure. The cone penetrometer is very sensitive to small differences in soil consistency.

Continuous Slot Wire-Wound Intake - A well intake that is made by winding and welding triangular-shaped, cold-rolled wire around a cylindrical array of rods. The spacing of each successive turn of wire determines the slot size of the intake.

Core Barrel - A steel tube used to collect rock core samples. The core barrel receives the rock core cut by the outer barrel as the borehole is advanced.

Cuttings - Formation particles obtained from a borehole during the drilling process.

Drill Rod - The rigid steel rod used to lower and retrieve cutting, coring and sampling equipment down the borehole.

Draw down - Distance between the static water level and water level while the well is being pumped or bailed at a constant rate.

Drilling Fluids - A water-based or air-based fluid used in the well drilling operation to remove cuttings from the borehole, to clean and cool the bit, to reduce friction between the inner barrel and the sides of the borehole and to seal the borehole.

Dual-Purpose Well - A well that can be used as both a monitoring and extraction or injection well.

Filter Pack - Sand, gravel, or glass beads that are uniform, clean and well-rounded that are placed in the annulus of the well between the borehole wall and the well intake to prevent formation material from entering through the well intake and to stabilize the adjacent formation.

Fines - Silt, clay, fine sand.

Grout - A fluid mixture of neat cement and water with various additives or bentonite of a consistency that can be forced through a pipe and emplaced in the annular space between the borehole and the casing to form an impermeable seal.

Heaving Formation - Unconsolidated saturated substrate encountered during drilling where the hydrostatic pressure of the formation is greater than the borehole pressure causing the sands to move up into the borehole.

Inner Barrel - The tool lowered through the inside of the outer barrel that can be configured for cutting, coring, or sampling.

Kelly Bar - A hollow steel bar or pipe that is the main section of drill string to which the power is directly transmitted from the rotary table to rotate the drill pipe and bit. The cross section of the kelly is either square, hexagonal, or grooved. The kelly works up and down through drive bushings in the rotary table.

Neat Cement - A mixture of Portland cement and water in the proportion of 5 to 6 gallons of clean water per bag (94 pounds) of cement.

Outer Barrel - The steel piping that serves to both cut downwards and to line the borehole walls to prevent hole collapse.

Overshot Tool - The tool that attaches to the inner barrel so that the barrel may be lowered through the outer barrel to depth on the wireline. The overshot tool is designed to attach to, or release from, the inner tube at depth.

Parameters - Groundwater variables, pH, specific conductivity, temperature, turbidity.

Pitch - The distance along the axis of an auger flight that it takes for the helix to make one complete 360 degree turn.

Purge water - Any water removed from the well via bailing, pumping, or air lift.

Rotary Table - A mechanical or hydraulic assembly that transmits rotational torque to the kelly, which is connected to the drill pipe and the bit. The rotary table has a hole in the center through which the kelly passes.

Saturated annulus - The portion of the annulus that is below the aquifer.

Sieve Analysis - Determination of the particle-size distribution of soil, sediment, or rock by measuring the percentage of the particles that will pass through standard sieves of various sizes.

Split-Spoon Sampler - A thick-walled steel tube split lengthwise used to collect soil samples. The sampler is commonly lined with metal sample sleeves and is driven or pushed downhole by the drill rig to collect samples.

Thin-Walled Sampler - A sampling devise used to obtain undisturbed soil samples made from thin-wall tubing. The sampler is also known as a Shelby tube. The thin-wall sampler minimizes the most serious sources of disturbance: displacement and friction.

Tremie Pipe - A device, usually a small-diameter pipe, that carries grouting materials to the bottom of the borehole and that allows pressure grouting from the bottom up without introduction of appreciable air pockets.

VOCs - Volatile organic compounds.

Wireline - The steel cable used to lower and retrieve cutting, coring and sampling equipment down the borehole.

Yield - The rate at which a well will produce water.

ATTACHMENT B

SAMPLELOGGING FORM

SAMPLE LOG FORM

Sample I.D. ______________________ Sample Location I.D. ______________________

Mine Location ______________________ Sample Depth ______________________

Sample Collection Date ______________________

Sample Collection Time ______________________

Sample Collected by ______________________

Weather Conditions ______________________

Location Coordinates ______________________

Field USBR/USCS Descriptions ______________________

Major Divisions: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC Rock Unit(s) ______________

☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

Qualifiers: ☐ Trace ☐ Minor ☐ Some; sand size ____________ ☐ Fine ☐ Medium ☐ Coarse

Moisture: ☐ Dry ☐ Moist ☐ Wet

Munsell Color ______________________

SAMPLE CONTAINER	PRESERVATIVE	ANALYTE	LAB VIAL WEIGHT (+ .01 G.)	EMPTY FIELD VIAL WEIGHT (+ .01 G.)	FILLED FIELD VIAL WEIGHT (+ .01 G.)

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ATTACHMENT C
UNIFIED SOIL CLASSIFICATION SYSTEM

FIELD GUIDE

ORDER OF DESCRIPTION

1. Soil type   2. USCS symbol   3. Color   4. Consistency/Density   5. Moisture
6. Grain size (sands and gravels)   7. Cementation   8. Plasticity   9. Miscellaneous

EXAMPLE DESCRIPTION

Poorly-graded sand with gravel (SP), light brown, loose, moist, predominantly fine sand, trace medium sand, 20% fine gravel, hydro carbon odor and staining

UNIFIED SOIL CLASSIFICATION SYSTEM

1				2
COARSE-GRAINED SOILS <50% passes #200 sieve	**GRAVELS** <50% coarse fraction passes #4 sieve	**GRAVELS** with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	**GW**
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	**GP**
		GRAVELS with ≥15 fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	**GM**
			Clayey gravels, poorly-graded gravel-sand-clay mixture	**GC**
	SANDS ≥50% coarse fraction passes #4 sieve	**SANDS** with little or no fines	Well-graded sands, gravelly sands, little or no fines	**SW**
			Poorly-graded sands, gravelly sands, little or no fines	**SP**
		SANDS with ≥15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	**SM**
			Clayey sands, poorly-graded sand-gravel-clay mixtures	**SC**
FINE-GRAINED SOILS ≥50% passes #200 sieve	**SILTS AND CLAYS** liquid limit <50		Inorganic silts and very fine sands, silty or clayey fine sands, silts with slight plasticity	**ML**
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	**CL**
			Organic silts and clays of low plasticity	**OL**
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	**MH**
			Inorganic clays of high plasticity, fat clays	**CH**
			Organic silts and clays of medium-to-high plasticity	**OH**
HIGHLY ORGANIC SOILS			Peat, humus, swamp soils with high organic content	**PT**

SOIL TYPE MODIFIERS

Sand/Gravel Term	% fines	**Silt/Clay** Term	% fines
trace	<5	trace	<5
with	5-15	with	15-30
clayey/silty	>15	sandy/gravelly	>30

NOTE: Well-graded (wide range of grain sizes) = poorly sorted; poorly-graded (predominantly one grain size) = well sorted

3 **COLOR** Assign color using Munsell Soil Color Chart (1992) if possible

4 **CONSISTENCY** (Silts and clays)

Term	Blow/ft* 1.4"ID	2.0"ID	2.5"ID	Field Test (when blow counts not available)
very soft	0-2	0-2	0-2	Easily penetrated several inches by thumb; extrudes when squeezed
soft	2-4	2-4	2-4	Easily penetrated one inch by thumb; molded by light pressure
medium stiff	4-8	4-8	4-8	Penetrated over 1/2 inch by thumb with moderate effort; molded by strong pressure
stiff	8-15	9-17	9-18	Indented by 1/2 inch by thumb but penetrated only with great effort
very stiff	15-30	17-39	18-42	Readily indented by thumbnail
hard	30-60	39-78	42-85	Indented with difficuty by thumbnail
very hard	>60	>78	>85	Thumbnail will not indent soil

* = 140 pound hammer dropped 30 inches

DENSITY (Sands and gravels)

Term	Blow/ft* 1.4"ID	2.0"ID	2.5"ID
very loose	0-4	0-5	0-7
loose	4-10	5-12	7-18
medium dense	10-29	12-37	18-51
dense	29-47	37-60	51-86
very dense	>47	>60	>86

5 MOISTURE CONTENT

Term	Field Test
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

6 GRAIN SIZE

Term	Sieve size	Grain size	Approximate size
Boulders	12 inches	>12 inches	Larger than basketball-size
Cobbles	3-12 inches	3-12 inches	Fist-size to basketball-size
Gravel - Coarse	3/4-3 inches	3/4-3 inches	Thumb-size to fist-size
Fine	#4-3/4 inches	0.19-0.75 inches	Pea-size to thumb-size
Sand - Coarse	#10-#4	0.079-0.19 inches	Rock salt-size to pea-size
Medium	#40-#10	0.017-0.079 inches	Sugar-size to rock salt-size
Fine	#200-#40	0.0029-0.017 inches	Flour-size to sugar-size
Fines	Passing #200	<0.0029 inches	Flour-size and smaller

7 CEMENTATION

Term	Field Test
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

8 PLASTICITY

Nonplastic	Thread (1/8 inch or 3mm) cannot be rolled at any water content.
Low	Thread can barely be rolled. Lump cannot be formed when drier than the plastic limit.
Medium	Thread is easy to roll and not much time is required to reach the plastic limit. Thread cannot be rerolled after reaching the plastic limit. Lump crumbles when drier than the plastic limit.
High	Takes considerable time rolling and kneading to reach the plastic limit. Thread can be rerolled several times after reaching the plastic limit. Lump can be formed without crumbling when drier than the plastic limit

9 MISCELLANEOUS

Plasticity (if applicable)
Organics, carbon, vegetation, debris
Structure (e.g., layering)
Coloration (staining, oxidation, mottling)
Lithology (e.g., quartz, mafic minerals)
Fill or native material
Degree of rounding/angularity
Stratigraphic unit (if known)
Drilling rate and rig behaviour
Heaving sands
Loss of drilling fluid
Caving/sloughing
Odor (organic, petroleum, or chemical)
Organic vapor readings
Fracturing

ROCK CLASSIFICATION

Rock name Color Weathering Fracturing Competency Mineralogy Miscellaneous

▽ Depth to first water (time and date)

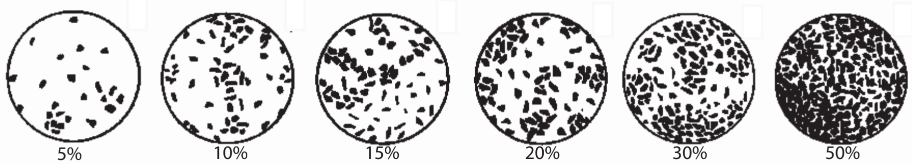
▼ Depth to water after drilling (time and date)

UNIFIED SOIL CLASSIFICATION SYSTEM
FIELD GUIDE

Flow Chart for Identifying Fine-Grained Soils (more than 50% fines)

				GROUP NAME
CL	< 30% plus No. 200	< 15% plus No. 200		Lean clay
		15–29% plus No. 200	% sand ≥ % gravel	Lean clay with sand
			% sand < % gravel	Lean clay with gravel
	≥ 30% plus No. 200	% sand ≥ % of gravel	< 15% gravel	Sandy lean clay
			≥ 15% gravel	Sandy lean clay with gravel
		% sand < % of gravel	< 15% sand	Gravelly lean clay
			≥ 15% sand	Gravelly lean clay with sand
ML	< 30% plus No. 200	< 15% plus No. 200		Silt
		15–29% plus No. 200	% sand ≥ % gravel	Silt with sand
			% sand < % gravel	Silt with gravel
	≥ 30% plus No. 200	% sand ≥ % of gravel	< 15% gravel	Sandy silt
			≥15% gravel	Sandy silt with gravel
		% sand < % of gravel	< 15% sand	Gravelly silt
			≥ 15% sand	Gravelly silt with sand
CH	< 30% plus No. 200	< 15% plus No. 200		Fat clay
		15–29% plus No. 200	% sand ≥ % gravel	Fat clay with sand
			% sand < % gravel	Fat clay with gravel
	≥ 30% plus No. 200	% sand ≥ % of gravel	< 15% gravel	Sandy fat clay
			≥15% gravel	Sandy fat clay with gravel
		% sand < % of gravel	< 15% sand	Gravelly fat clay
			≥ 15% sand	Gravelly fat clay with sand
MH	< 30% plus No. 200	< 15% plus No. 200		Elastic silt
		15–29% plus No. 200	% sand ≥ % gravel	Elastic silt with sand
			% sand < % gravel	Elastic silt with gravel
	30% plus No. 200	% sand ≥ % of gravel	< 15% gravel	Sandy elastic silt
			≥15% gravel	Sandy elastic silt with gravel
		% sand < % of gravel	< 15% sand	Gravelly elastic silt
			≥ 15% sand	Gravelly elastic silt with sand

Estimated Percentages



NOTES: — Percentages are based on estimating amounts of fines, sand and gravel to the nearest 5%.
— Material passing a No. 200 sieve is classified as fine; material retained on a No. 200 sieve is classified as sand and coarse-grained particles.

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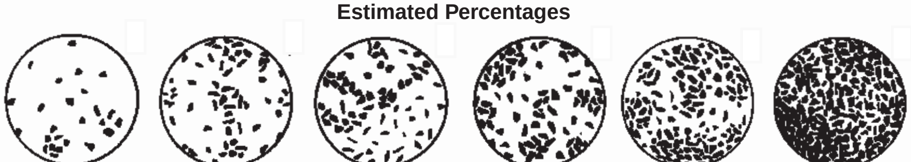
UNIFIED SOIL CLASSIFICATION SYSTEM
FIELD GUIDE

Flow Chart for Identifying Coarse-Grained Soils (less than 50% fines)

				GROUP SYMBOL		GROUP NAME
GRAVEL % gravel > % sand	≤ 5% fines	Well-graded		GW	< 15% sand	Well-graded gravel
					≥ 15% sand	Well-graded gravel with sand
		Poorly-graded		GP	< 15% sand	Poorly-graded gravel
					≥ 15% sand	Poorly-graded gravel with sand
	>5 - <15% fines	Well-graded	fines = ML or MH	GW-GM	< 15% sand	Well-graded gravel with silt
					≥ 15% sand	Well-graded gravel with silt and sand
			fines = CL or CH	GW-GC	< 15% sand	Well-graded gravel with clay
					≥ 15% sand	Well-graded gravel with clay and sand
		Poorly-graded	fines = ML or MH	GP-GM	< 15% sand	Poorly-graded gravel with silt
					≥ 15% sand	Poorly-graded gravel with silt and sand
			fines = CL or CH	GP-GC	< 15% sand	Poorly-graded gravel with clay
					≥ 15% sand	Poorly-graded gravel with clay and sand
	≥ 15% fines		fines = ML or MH	GM	< 15% sand	Silty gravel
					≥ 15% sand	Silty gravel with sand
			fines = CL or CH	GC	< 15% sand	Clayey gravel
					≥ 15% sand	Clayey gravel with sand
SAND % sand > % gravel	≤ 5% fines	Well-graded		SW	< 15% gravel	Well-graded sand
					≥ 15% gravel	Well-graded sand with gravel
		Poorly-graded		SP	< 15% gravel	Poorly-graded sand
					≥ 15% gravel	Poorly-graded sand with gravel
	>5 - <15% fines	Well-graded	fines = ML or MH	SW-SM	< 15% gravel	Well-graded sand with silt
					≥ 15% gravel	Well-graded sand with silt and gravel
			fines = CL or CH	SW-SC	< 15% gravel	Well-graded sand with clay
					≥ 15% gravel	Well-graded sand with clay and gravel
		Poorly-graded	fines = ML or MH	SP-SM	< 15% gravel	Poorly-graded sand with silt
					≥ 15% gravel	Poorly-graded sand with silt and gravel
			fines = CL or CH	SP-SC	< 15% gravel	Poorly-graded sand with clay
					≥ 15% gravel	Poorly-graded sand with clay and gravel
	≥ 15% fines		fines = ML or MH	SM	< 15% gravel	Silty sand
					≥ 15% gravel	Silty sand with gravel
			fines = CL or CH	SC	< 15% gravel	Clayey sand
					≥ 15% gravel	Clayey sand with gravel

Estimated Percentages



5% 10% 15% 20% 30% 50%

NOTES: — Percentages are based on estimating amounts of fines, sand and gravel to the nearest 5%.
— Material passing a No. 200 sieve is classified as fine; material retained on a No. 200 sieve is classified as sand and coarse-grained particles.

ATTACHMENT D
SOIL BORING LOG FORM

BORING LOG NUMBER:

SHEET ___ OF ___

LOC. ID: ELEVATION: DATUM:

PROJECT NAME.: DRILL DATE:

INCLINATION: AZIMUTH: HAMMER WEIGHT: DATE FINISHED:

LOCATION SKETCH

DEPTH (UNITS)	BORING METHOD	SOIL PROFILE SOIL DESCRIPTION	GRAPHIC LOG	SAMPLES USCS	NUMBER	TYPE	BLOW COUNT/6"	RECOVERY	ADDITIONAL COMMENTS
0									
5									
10									
15									
20									
25									
30									
35									
40									
45									

DEPTH UNITS: ______________ LOGGED BY: ______________

DRILLING CONTRACTOR: ______________ CHECKED BY: ______________

DRILLER: ______________

SOIL BORING LOG FORM

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY

PROJECT No.:

AutoCAD FILE:

SCALE: FIGURE No:

ATTACHMENT E
CRITERIA FOR DESCRIBING PLASTICITY

CRITERIA FOR DESCRIBING PLASTICITY	
Description	**Criteria**
Nonplastic	A 1/8-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

ATTACHMENT F

CRITERIA FOR DESCRIBING DENSITY AND CONSISTENCY

DENSITY/CONSISTENCY BASED UPON BLOW COUNTS							
Density (Sand and Gravel) Blows/ft*				**Consistency (Silt and Clay) Blows/ft***			
Term	**1.4" ID**	**2.0" ID**	**2.5" ID**	**Term**	**1.4" ID**	**2.0" ID**	**2.5" ID**
very loose	0-4	0-5	0-7	very soft	0-2	0-2	0-2
loose	4-10	5-12	7-18	soft	2-4	2-4	2-4
medium dense	10-29	12-37	18-51	medium stiff	4-8	4-9	4-9
dense	29-47	37-60	51-86	stiff	8-15	9-17	9-18
very dense	>47	>60	>86	very stiff	15-30	17-39	18-42
				hard	30-60	39-78	42-85
				very hard	>60	>78	>85
* 140 lb. hammer dropped 30 inches							

CRITERIA FOR DESCRIBING CONSISTENCY BASED UPON THUMB TEST	
Description	**Criteria**
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about 1/4 in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

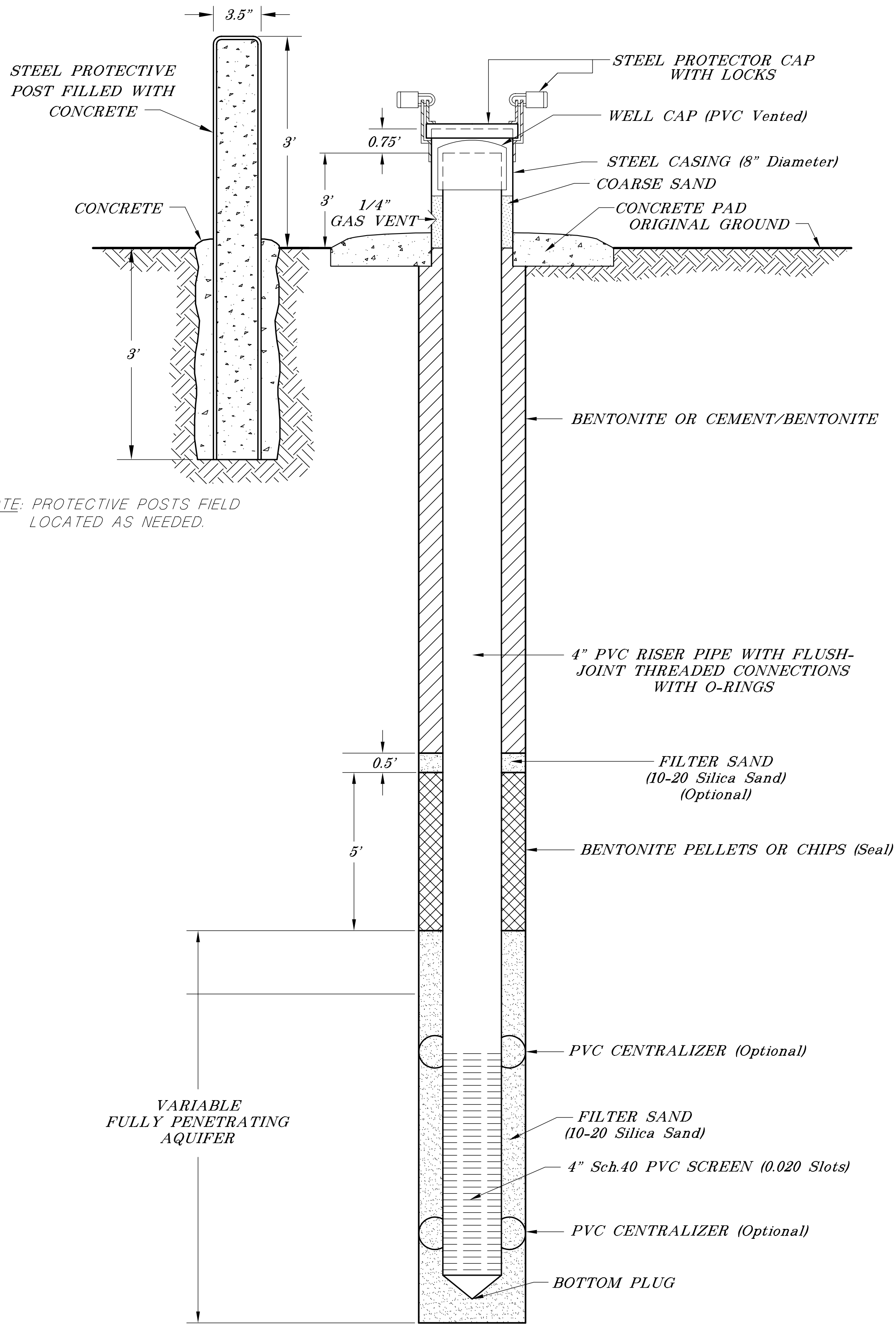
ATTACHMENT G

CRITERIA FOR DESCRIBING STRUCTURE

CRITERIA FOR DESCRIBING STRUCTURE	
Description	**Criteria**
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

ATTACHMENT H

TYPICAL MONITOR WELL INSTALLATION FORM



NOTE: PROTECTIVE POSTS FIELD LOCATED AS NEEDED.

Project No.:	Design By:	Scale: N.T.S.
File: TYP-WELL.DWG	Drawn By:	Date:

TYPICAL MONITORING WELL INSTALLATION

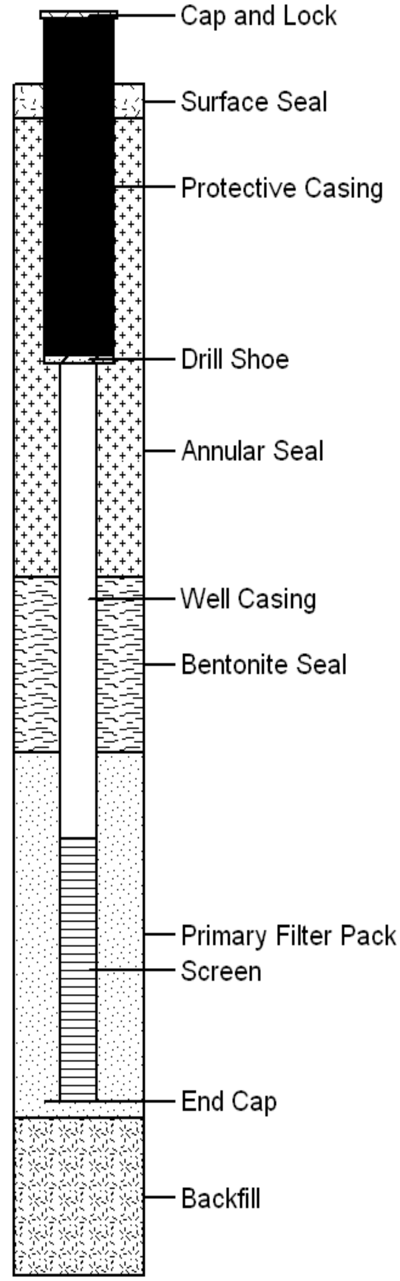
ATTACHMENT I

MONITORING WELL CONSTRUCTION FORM

Project Name:	Date Drilled: From to	**<u>Well ID</u>**
Project Number:	Date Installed: From to	

Longitude:	Latitude:	Elevation:	Datum:

Protective Casing:	BGS	AGS
Well Casing Top:	BGS	AGS
Well Casing Schedule: 40/80 Other:		
Well Casing Diameter:	in	
Screen Joint:	(BGS)	
Screen Material:	Manufacturer:	
Screen Type:	Slot Size:	
End Cap Bottom:	(BGS)	
Borehole Bottom:	(BGS)	
Borehole Diameter:	(BGS)	
Surface Seal (BGS): Top:	Bottom:	
Surface Seal Material:		
Annular Seal (BGS): Top:	Bottom:	
Annular Space Seal Material:		
Primary Filter Pack: (BGS) Top:	Bottom:	
Sand Size:	Volume Added:	Ft^3
Manufacturer:	Cap and Lock:	
Protective Casing:		
Inside diameter:		
Drainage ports:		
Backfilled with:	From: to	(BGS)
Drilling Method:		
Drilling Fluids:		
Drilling Additives: (Describe)		
Water level after completion:	BGS	TOC
USCS Soil Classification @ Screen:		
GP GM GC GW SW SP SM SC ML MH CL CH	Bed Rock	
Bedrock Classification:		
Formation/Unit @ Screen:		



Well Drilled By	Well Installed By
Firm:	Firm:
Operator:	Installer:

Notes:

All lengths and depths are recorded in feet unless otherwise stated.

ATTACHMENT J

WELL DEVELOPMENT RECORD
WELL VOLUME CHART

WELL DEVELOPMENT RECORD

Well Number:

Job No. ____________________ Project Name:________________________ Page:___ of ___

Date(s): ____________________________ Comments: ____________________________

Developed by: ________________________ ____________________________

Measuring Point (MP) of Well: ______________

Screened Interval (ft bgs): __________________ Starting H_2O Level (BMP): ____________

Filter Pack Interval (ft bgs): _________________ Casing Stickup TOC (ft): ____________

Development Method: ______________________ Casing Diameter (in ID): ____________

Casing Volume (gal):

QUALITY ASSURANCE

Methods (describe)

Cleaning Equipment:

Development:

Disposal of Purge Water:

Instruments (indicate make, model, id.)

Water Level:	Thermometer:
pH Meter:	Field Calibration:
Conductivity Meter:	Field Calibration:
Turbidity Meter:	Field Calibration:
Other:	Field Calibration:

DEVELOPMENT MEASUREMENTS

Date/Time	Cumul. Vol. (gal)	Temp. (C)	Field EC (_______)	Color	Turbidity	Other _______	Remarks

Total Discharge (gal): ____________________ Casing Volumes Purged: ____________________

Observations/Comments: ____

Abbreviations:

BMP = below measuring point

BGS = below ground surface

Cumul. Vol. = cumulative volume removed

ID = inside diameter

C = Celsius

gal = gallons

ft = feet

in = inches

Filename: Well-devel.dwg

ATTACHMENT K

WATER LEVEL READINGS FORM

Record of Water Level Readings

Job Number: Project Name: Location:

Loc. ID	Date	Time	Measuring Device / Unit Number	Refrence Point	Depth to Water	Recorded By	Comments

Record of Water Level Readings, Rev: 4/10/2008

ATTACHMENT L

TIME INTERVALS FOR MANUAL AND ELECTRONIC MEASUREMENTS OF DRAWDOWN

SUGGESTED MANUAL MEASUREMENT FREQUENCY USING CALIBRATED ELECTRONIC WATER-LEVEL INDICATORS

ELAPSED TIME	MEASUREMENT FREQUENCY
0-20 minutes	30 seconds
20-40minutes	2 minute
40-60 minutes	5 minutes
60-120 minutes	10 minutes
2-12 hours	1 hour
12 hours to 3 days	2 hours

LOGARITHMIC TIME INTERVAL SCHEDULE FOR PRESSURE TRANSDUCERS AND DATA LOGGERS

LOG CYCLE	MEASUREMENT INTERVAL	TOTAL DATA POINTS PER CYCLE
0-20 seconds	0.2 second	101
20 -60 seconds	1 second	40
1-10 minutes	12 seconds	45
10-100 minutes	2 minutes	45
100-1,000 minutes	20 minutes	45
1,000-10,000 minutes	200 minutes	45

APPENDIX A-2

COLLECTION OF GROUNDWATER QUALITY SAMPLES

SOP-NW-5.3

Collection of Groundwater Quality Samples

1.0 SCOPE

This technical procedure establishes methods for collecting groundwater samples for chemical analysis representative of aquifer water quality.

This technical procedure is designed to cover general techniques for obtaining valid, representative samples from groundwater monitoring wells. The scope is intended to provide guidance while preparing for and during actual field sampling activities. The specific methods to be used at each monitoring well are described in the applicable workplan or sampling analysis plan (SAP).

This technical procedure is applicable to all MWH personnel engaged in the collection of groundwater samples from wells for purposes of chemical analysis and are intended to be used in conjunction with a project-specific workplan or SAP.

2.0 DEFINITIONS

2.1 Dedicated Pump System

A dedicated pump system is a permanently installed device for removing water from a well. The system is not removed from the well and does not have the potential to become contaminated between uses.

2.2 Well Storage Volume

Well storage volume is defined as the volume of water enclosed by the well casing and screen gravel/sand pack under equilibrium conditions.

2.3 Bailer

A bailer is a tubular device, with a check-valve at the top and/or bottom, used for collecting and removing groundwater from wells. The three most common types of bailers are: Single check valve; double check valve; and "thief" or "messenger" samplers.

- A single check valve bailer will expose part of the sample to the atmosphere. The typical sample transfer occurs by inserting a tube into the bottom of the bailer, pushing up the check valve, which allows the water to be released into the sample container. If used for VOC sampling the bailer should have a sample cock or draft valve at or near the bottom of the sampler allowing withdrawal of the sample from the well below the exposed surface water. Otherwise, discard the first few inches of sample at the bottom of the bailer.

- The double check valve sampler allows for point source sampling at a specific depth. The liquid will pass through the sampler while it is descending until the desired depth is reached. Once retrieval of the sample commences, both check valves close simultaneously, thereby allowing the specific depth to be sampled.

- The thief or messenger sampler also allows for point source sampling at a specific depth. A weighted messenger is dropped down the suspension line and closes the sampling vessel thus obtaining a sample at the desired depth.

To avoid potential sources of contamination, keep the bailer suspension lines off the ground and away from any other potentially contaminating sources to minimize the possibility of contaminants being carried down into the well. If needed, a decontaminated tarp or plastic bag is recommended for storage of the bailer suspension line.

2.4 Non-Dedicated Sampling Apparatus

A non-dedicated sampling apparatus is sampling equipment that is not used solely for collection of groundwater samples from a single well. This term is also used to describe equipment that is only used for sampling a single well, but is removed from the well and could potentially become contaminated.

2.5 Groundwater Sample

A groundwater sample is defined as water acquired from a well for chemical analyses that is representative of groundwater within the aquifer or the portion of the aquifer being sampled.

2.6 Positive Pressure Pump

A positive pressure pump is a device for removing water from a well by forcing water to the surface through positive pressure when operated below the water level in a well. A positive pressure pump may be operated electrically, mechanically, or by air/nitrogen pressure. Submersible impeller, bladder, and check valve pumps are common types of positive pressure pumps.

2.7 Suction Lift Pump

A suction lift pump is a device for removing water from well by negative pressure (suction). Direct line, peristaltic and centrifugal pumps are the three types of suction lift pumps. The limitation for lifting water by suction is usually 20 to 25 feet. These pumps are only acceptable for non-volatile analytes and analytes that are not affected by aeration or changes in pH. They are useful as purging devices for shallow groundwater wells.

Peristaltic pumps are preferred when a suction lift pump is required. This is the only suction lift pump, of the three mentioned above, in which the liquid being sampled moves entirely within the sample tubing. The groundwater sample never contacts the actual pump apparatus during sampling thus eliminating a possible source of sample contamination from the actual pump, lubricants, or parts.

Standard silicon tubing is the most commonly used sample tubing. Most pump manufacturers and rental companies offer acceptable tubing lined with TFE-fluorocarbons or Viton. The National Council of the Paper Industry for Air and Stream Improvement recommends medical grade silicon tubing for organic sampling;

however, it is limited to use over a restricted range of ambient temperatures. Standard silicon tubing uses an organic vulcanizing agent, which has been shown to leach into samples.

2.7 Sample Bottles

Sample bottles are containers specifically designed and prepared for storing liquid samples. Sample bottle type, material, size, and type of lid shall be as specified in the governing workplan or SAP. Sample bottles must be properly cleaned and prepared by a laboratory or the manufacturer in accordance with standard laboratory methods and procedures. Coordinate with selected analytical laboratory for bottle type and preparation requirements.

2.8 Acceptable Material

Acceptable materials are defined as pump systems that have minimal effect on water quality when used to obtain groundwater samples from wells. The use of pumps is dependent on the analyses being conducted on the acquired samples. The parts of pumps that will contact the groundwater sample contain only acceptable materials.

3.0 RESPONSIBILITIES

3.1 Field Sampling Engineer

The Field Sampling Engineer is responsible for sample collection, sample custody in the field, sample preservation, field testing, total and accurate completion of data sheets, sample shipment and delivery of data to the Project Manager and designated project secretary, all as described in this technical procedure.

3.2 Field Team Leader

The Field Team Leader is responsible for supervising the Field Sampling Engineers. Supervision includes ensuring that samples are collected, documented, preserved, field analyzed, handled and shipped to the appropriate laboratory as specified in project work documents and this technical procedure.

3.3 Project Manager

The Project Manager has overall management responsibilities for the project, is responsible for designing the sampling program, for arranging the logistics of the program, and for providing any required clarifications in the use of this procedure. The Project Manager may assume the responsibilities of the Task Leader on smaller projects.

The Project Manager is also responsible for maintaining project files and filing project documents, project correspondence, chain of custody forms, groundwater purging and sampling forms, generated data, and other associated and pertinent project information.

4.1 DISCUSSION

The following is a listing of general procedures that should be followed during every sampling event.

- Groundwater samples shall be collected in quantities and types as described in the governing workplan or SAP.
- Water-level data collection (see MWH SOP-5 for appropriate procedure).
- Determination of well storage volume (see Section 5.2.1, below).

- All instruments used for field analyses should be calibrated in accordance with the manufacturer's instructions.

- All non-dedicated sampling equipment shall be decontaminated before and after each use.

- If so directed by the governing workplan or SAP, purge water and decontamination fluids shall be captured and contained for disposal.

- Samples shall be collected in properly prepared containers of the appropriate size and type, and all samples shall be appropriately labeled and sealed, as required by the governing workplan or SAP.

- Samples shall be stored and transported in coolers chilled to 4º Celsius or less. Sample handling and chain of custody shall be as specified in the governing workplan or SAP.

- The Groundwater Purging and Sampling Form (see Appendix A) and the field log book shall be used to document daily site activities and sample collection.

- All variations from established procedure shall be documented on the Groundwater Purging and Sampling Form (see Appendix A) and shall be approved by the Project Manager prior to proceeding with the work variation.

5.1 General Considerations

5.1.1 Decontamination

All non-dedicated sampling equipment that may contact the sample must be decontaminated before and after each use unless it is disposable and being used for only a single well. Non-dedicated pumps or bailers require decontamination of internal and external parts prior to being lowered into the well. Non-dedicated equipment shall first be washed with clean tap water (whose chemistry is known and acceptable), non-phosphate detergent, and rinsed with clean tap water. For inorganic analytes a weak hydrochloric acid (HCl) or nitric acid (HNO_3) solution shall be used for the second wash. For organic analytes, reagent-grade methanol shall be used for the second wash. A final rinse with organic-free distilled/deionized water shall complete the decontamination. At a minimum, all acid and methanol wash solutions must be captured (see Section 5.5.1, below).

5.1.2 Sample Quantities, Types, and Documentation

Samples shall be collected in quantities and types as specified in the governing workplan or SAP.

The Groundwater Purging and Sampling Form (Appendix A) and the field logbook shall be used to document daily site activities and sample collection (see Section 5.6, below). Samples shall be transferred to the analytical laboratory under formal chain of custody, which shall be documented and maintained in accordance with procedure.

5.1.3 Sample Containers

All sample bottles must be properly cleaned and prepared. Coordinate with selected analytical laboratory for appropriate sample bottle types and preparation requirements. All groundwater samples shall be labeled and sealed and immediately placed in coolers chilled to 4º Celsius or less with securely closed lids and custody seals on the outside of the cooler for storage and transport. Samples must be received by the analytical laboratory in sufficient time to conduct the requested analyses within the specified holding time.

5.1.4 Acceptable Materials

Stainless steel and fluorocarbon resin (Teflon, PTFE, FEP, or PFA) are acceptable materials that may contact groundwater samples. Glass is an acceptable material for contacting samples except when silica or fluoride analyses are to be performed. Plastics (PVC, polyethylene**,** polypropylene, tygon) are an acceptable material for contacting samples when the analyses are for inorganic analytes (metals, radionuclides, anions, cations).

5.1.5 Sample Acquisition

Groundwater samples shall be removed from the well with the use of a permissible pump or bailer. Electric positive-pressure pumps, as defined in Section 3.6, made of acceptable materials are permissible to use for acquiring any groundwater sample. Air/nitrogen pressure activated positive-pressure pumps made of acceptable materials are permissible to use for acquiring any groundwater sample if the air/nitrogen does not contact the sample. Positive-pressure pumps operated by mechanically forcing water through check valves are permissible for acquiring groundwater samples. Bailers made of acceptable materials are permissible for acquiring groundwater samples.

Peristaltic pumps and airlift pumps are not preferred for acquiring groundwater samples but are permissible when samples are to be analyzed for analytes that are not volatile, are not affected by aeration, and are not affected by changes in pH.

Other types of pumps (peristaltic, centrifugal, air lift, recirculation, etc.) may be used for purging groundwater from wells prior to sample acquisition, if: (1) pump materials contacting well water are acceptable; (2) pumping does not aerate or change the pH of the remaining well water; and (3) pumped water does not mix with remaining well water during pumping or after the pumping is stopped.

5.2 Equipment And Materials

If wells are equipped with dedicated pump systems, equipment to operate the dedicated pump systems (i.e., air compressor, compressed air or nitrogen cylinders, electric generator, etc.) as well as non-dedicated sampling apparatus, such as surface discharge tubing and valves, may be necessary.

If wells do not have permissible and dedicated pump systems, permissible pump systems or bailers and accessories of small enough diameter to enter the wells will be necessary. All equipment that could contact the sample shall be made of acceptable materials.

Sample bottles and preservatives appropriate for the parameters to be samples will be necessary. Coordinate with selected analytical laboratory for bottle type and preparation requirements.

Field test equipment necessary for groundwater sampling:

- Thermometer
- pH meter and standards
- Conductivity meter and standards
- dissolved oxygen meter (optional)
- turbidity meter and standards
- Filtration apparatus (0.45 micron), if necessary
- Depth to water measuring device
- Coolers and ice packs
- Organic-Free Distilled or deionized water
- Cleaning equipment (scrub brushes) and solutions (non-phosphate detergent)
- Indelible ink pens and felt-tip markers
- Sample labels and seals
- Container(s) for capturing, containing, treating and measuring waste decontamination solutions, if necessary.
- Well specifications
- Groundwater Purging and Sampling Forms (Appendix A)
- Field logbook
- Chain of Custody Forms (provided by selected laboratory)
- As required, 55 gallon steel drums fitted with bung holes, or suitable tank(s) for containing purged groundwater.
- Additional preservatives (i.e., HNO_3)
- Copy of this SOP, SOP-5 and the governing workplan or SAP.

5.3 Groundwater Sample Acquisition

5.3.1 Purging the Well

The pump or bailer shall be used and operated in accordance with the manufacturer's operational manual. Before collecting the actual groundwater sample, a minimum of three (3) well bore storage volumes of water shall be purged from the well by pumping unless low-flow sampling techniques are being employed. Calculate this volume by measuring the depth to water and subtracting this depth from the total depth of the well. If a gravel/sand pack surrounds the screen, the pore volume of the gravel/sand pack (assume a porosity of 25 percent if unknown) shall be added to the total well volume. While purging water from the well, the conductivity, pH, temperature, dissolved oxygen (optional) and turbidity of the water shall be periodically measured. If the conductivity (within 10%), pH (within 0.1 pH units), temperature (within 0.5 degrees Celsius), dissolved oxygen (within 10%) or turbidity (within 10% and less than 5 NTU) of the water has not stabilized when a minimum of three (3) well volumes have been purged, then continue to purge water until these parameters stabilize as specified above. If the parameters of interest in the investigation include VOCs, care must be taken to ensure that purging does not induce degassing within the well. Where the well screen and sand pack are completely below the water table, the rate of purging should be controlled such that it does not draw the water level in the well below the top of the well screen. Where the well screen and sand pack are intersected by the groundwater level, the rate of purging should correspond with the rate of sampling, if continuous sampling methods are used. Large drawdowns in water table wells should be avoided. Purged groundwater that has a reasonable potential of containing hazardous substances shall be captured and characterized prior to discharge or disposal (see Section 5.5.1, below). Record the time after each well volume has been purged in order to keep track of actual pumping rate.

5.3.2 Samples for Major Cation, Metal, and Metallic Radionuclide Analyses

Samples for major cation, metal, and metallic radionuclide analyses (including Se) shall be immediately filtered after acquisition. Filtration is best accomplished with the use of an in-line filter system in which the sample is directly fed from the discharge port of a positive-pressure pump through the filter and into the appropriate sample bottle. A less preferred but acceptable method is the collection of an adequate amount of sample from a permissible positive-pressure pump or bailer into a properly cleaned and prepared high-density linear polyethylene or glass bottle. Samples shall be immediately fed through the filter and collected directly into the appropriate sample bottle. The final filter pore size should be 0.45 micron. (Note: New filters shall be used for each sample, and the filter system must be decontaminated before and after each sample.) These groundwater samples shall be preserved after filtration with nitric acid ($HN0_3$) to a pH less than 2.

In addition, if toxic metal or priority pollutant metal analyses are to be performed, an unfiltered sample will also be obtained (in addition to the filtered sample) directly from a permissible positive-pressure pump discharge port or from the bailer into appropriate sample bottles and preserved with nitric acid ($HN0_3$) to a pH less than 2. The only exception is analysis of chromium VI, in which case preservatives shall not be added to the sample.

5.3.3 Samples for Cyanide Analyses

Samples for cyanide analyses shall be collected directly into appropriate sample bottles from the bailer or the port of a positive-pressure pump. Samples shall not be filtered nor shall they be allowed to overflow the sample bottle. Samples shall be immediately preserved with sodium hydroxide (NaOH) to a pH greater than 12.

5.3.4 Samples for Major Anion and Biological Oxygen Demand (BOD) Analyses

Samples for major anions (chloride, fluoride, sulfate, alkalinity, acidity, total silica, bromfide) and for biological oxygen demand shall be collected directly into appropriate sample bottles from the port of the pump or from the bailer. These samples do not require filtration, but may be filtered, if desired. Preservatives shall not be added.

5.3.5 Samples for Total Phosphate and Orthophosphate Analyses

Groundwater samples for total phosphate and orthophosphate analyses shall be immediately filtered after initial sample acquisition. Filtration is best accomplished with an in-line system in which a positive-pressure pump discharge port feeds groundwater directly through the filter system into an appropriate sample bottle. A less preferred but acceptable method is to collect a liter of sample from a positive-pressure pump or bailer in a properly cleaned and prepared high-density polyethylene or glass bottle, and then immediately feed the sample through a filter system which discharges into the appropriate sample bottle. The final filter pore size shall be 0.45 micron. (Note: New filters must be used for each sample and the filter system must be decontaminated before and after each use.) Samples shall be immediately preserved with sulfuric acid (H_2SO_4) to pH less than 2.

5.3.6 Samples for Nitrogen Compound, Chemical Oxygen Demand, Oil and Grease, and Total Organic Carbon Analyses

Groundwater samples for nitrogen compound, chemical oxygen demand, oil and grease, and total organic carbon analyses shall be collected directly into appropriate sample bottles from a permissible positive pressure pump discharge port or from the bailer. These samples shall not be filtered and shall be preserved with sulfuric acid (H_2SO_4) to a pH less than 2.

5.3.7 Samples for Analysis of Total Dissolved Solids

Groundwater samples for analyses of total dissolved solids shall be immediately filtered in the field by methods discussed in Section 5.3.3 above, and collected directly into an appropriate sample bottle. Samples shall not be preserved with additives.

5.4 Field Analyses

5.4.1 Calibration of Instruments

All instruments used for field analyses shall be calibrated prior to use and daily during use. Only equipment with a calibration tag showing a recall date later than the anticipated date of use shall be taken to the field. Each instrument should be accompanied by a copy of the manufacturer's operation manual.

5.4.2 Water Temperature

A pocket thermometer or other measuring device shall be used to measure the temperature of the water on an aliquot of purged water obtained just before or after sampling. The thermometer reading shall be allowed to stabilize and shall be recorded to the nearest 0.5 degree centigrade. The instrument shall be rinsed with distilled or deionized water before and after each use.

5.4.3 pH Measurement

A pH meter shall be used to measure the pH of the sample on sample of purged water that was obtained just before or after sampling. Measurements shall be made immediately on the obtained sample (note: if possible, measure pH continuously on the purged water in a closed flow-through system). Calibration shall be in accordance with the manufacturer's procedures (provided with the instrument). Calibration shall be performed with standardized buffered pH solutions bracketing the range of expected pH and conducted at the beginning and end of each day. Before and after each reading, the probe shall be thoroughly rinsed with distilled or deionized water. The pH shall be recorded to one-tenth (or one-hundredth if the meter is stable enough) of a pH unit.

5.4.4 Conductivity Measurement

A conductivity probe shall be used for conductivity measurement on an aliquot of purged water obtained just before or after sampling. Measurements shall be made as soon as possible on the obtained aliquot. The meter shall be calibrated in accordance with manufacturer's procedures (provided with the instrument) with standardized KCl solutions. At a minimum calibration shall be performed at the beginning and ending of each days use. The conductivity shall be recorded to two significant figures. The temperature of the sample at the time of conductivity measurement shall also be recorded. The probe must be thoroughly rinsed with distilled/deionized water before and after each use.

5.4.5 Dissolved Oxygen Measurement

A dissolved oxygen meter is used to measure dissolved oxygen (DO) in water samples. Measurements shall be made immediately on aliquots obtained just before or after sample acquisition. (Note: If possible, measure DO continuously on the purge water in a closed flow-through system). The meter shall be calibrated in accordance with the manufacturer's procedures (provided with the instrument) using distilled/deionized water that has been allowed to equilibrate with the atmosphere at a given elevation. The salinity adjust shall be adjusted to the appropriate salinity of the water. Measure the temperature and concentration of dissolved oxygen in the sample while the salinity is on the fresh setting. The probe must be thoroughly rinsed with distilled or deionized water before and after each use. Measurements shall be recorded to the nearest 0.1 ppm concentration.

5.4.6 Turbidity Measurements

A turbidity meter shall be used to make turbidity measurements on aliquots of water samples obtained just before or after sample acquisition. Measurements shall be made as soon as possible on the obtained aliquot. Operation and calibration shall be in accordance with the manufacturer's procedures (provided with the instrument). Standardized solutions shall be used for calibration. The instrument shall be calibrated at least once during the purging and sampling of each well. The outside of the glass vials used for containing the aliquot for measurement must be wiped thoroughly dry before and after each use. Measurements shall be recorded to the nearest 0.1 NTU when less than 1 NTU; the nearest 1 NTU when between 1 and 10 NTU; and the nearest 10 NTU when between 10 and 100 NTU.

5.5 Capture And Disposal Of Purge Water And Decontamination Solutions

5.5.1 Purge Water

If specified in the applicable workplan or SAP, purged groundwater shall be captured and contained in 55 gallon steel drums or suitable tank(s). If so required, each drum or tank containing captured purge water shall be properly labeled with a weatherproof label as to the contents, the well(s) from which the contained purge water originated and the date in which the contents were generated. Storage of the drums or tanks shall be as specified in the project work documents or as directed by the Project Manager.

Captured and contained purge water shall be characterized for discharge, treatment and/or disposal. Characterization of the captured and contained purge water should be specified in the project work documents or by the Project Manager, but could rely on the analytical results of groundwater samples associated with each drum or tank, or could involve direct sampling and analyses of the contained water.

The requirements and options available for discharge, treatment and/or disposal are dependent upon many variables such as chemical consistency, local and state regulations, and location of site. Discharge, treatment, and/or disposal of captured and contained purge water must be in accordance with local, state and Federal regulations and shall be specified in the project work documents.

5.5.2 Decontamination Waste Solutions

Decontamination waste solutions that are generated during groundwater sampling include: spent detergent wash solutions; spent tap water rinses; any spent weak acid rinses, any spent methanol rinses; and spent final distilled/deionized water rinses. All spent acid and methanol rinses shall be captured and contained in plastic buckets or drums. Other spent decontamination waste solutions shall be captured and contained in appropriately sized buckets or drums if a reasonable potential exists for the spent solutions to contain hazardous substances. Project work documents shall address, or the Project Manager shall determine, whether spent decontamination solution requires capture and containment.

Captured and contained decontamination waste solutions shall be subject to the same procedures as described for purge water. Some noteworthy differences are as follows: (1) all acid solutions shall be neutralized with lime prior to discharge or disposal; (2) methanol solutions may be able to be evaporated if segregated from other waste solutions, if generated in small enough quantities, and if conditions are favorable; and (3) if quantities are sufficiently small, decontamination waste solutions (detergent washes, rinse waters, neutralized acid solutions) may be added to the captured and contained purge water that corresponds to the same well sampling effort.

5.6 Documentation

Documentation for sampling groundwater includes labeling sample bottles, and completing Groundwater Purging and Sampling Forms, and Chain of Custody Records, and securing individual samples or sample coolers with chain of custody seals.

5.6.1 Sample Labels

Samples shall be immediately labeled. Labels shall be waterproof. Information shall be recorded on each label with indelible ink. All blanks shall be filled in (N/A if not applicable). Groundwater sample designations shall be as specified in the governing workplan or SAP.

5.6.2 Groundwater Purging and Sampling Forms

Groundwater Purging and Sampling Forms (Appendix A) shall be used by the Field Sampling Engineer to record daily activities. Data shall be recorded on the Groundwater Purging and Sampling Form in chronological format. The time of each recorded event shall be included. The original Groundwater Purging and Sampling Form shall be submitted as soon as possible to the Project Manager or Task Leader.

5.6.3 Field Log Book

The field logbook is used by the Field Sampling Engineer to document the official raw field information for each sample that will be chemically analyzed. The original must be submitted as soon as possible to the Project Manager or Task Leader.

5.6.4 Chain of Custody Records

Sampling handling and chain of custody protocols shall be as specified in the governing workplan or SAP.

Chain of custody records will normally be used to record the custody and transfer of samples. Chain of custody forms are normally provided by the selected analytical laboratory. These forms shall be filled in completely (use N/A if not applicable). Tamper-proof seals shall be placed on either sample bottles or shipping coolers. The seal number shall be recorded on the Chain of Custody Form. The original form must accompany the samples to the analytical laboratory to be completed and returned to MWH for filing. A copy of the Chain of Custody Record documenting the transfer of samples from the field shall be submitted to the Project Manager or Task Leader.

6.0 REFERENCES

ASTM, 1995, ASTM Standards On Environmental Sampling - (PCN - 03-418095-38). ASTM, Philadelphia, PA.

U.S. EPA, 1986, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document, U.S. EPA/ Office of Solid Waste, Washington D.C.

U.S. EPA, 1986, Test Methods for Evaluating Solid Waste - (SW-846). U.S. EPA/Office of Solid Waste, Washington, D.C.

Wood, W.W. (1976), Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents, Techniques of Water-Resources Investigations of the United states Geological Survey, Book 1, Collection of Water Data by Direct Measurement, Chapter D2.

APPENDIX A

GROUNDWATER PURGING AND SAMPLING FORM

WELL SAMPLING FORM

Page: _____ of _____

Project No.: ___________ Client: P4 ___________ Date: ___________ Well ID: ___________

Task: ___________ Field Crew: ___________

Measuring Point (MP): ___________ Water Level (WL): ___________ ft below MP

Sampling Method (see applicable calculations below): ___________ Device: ___________

Low Flow Sampling

Minimum Purge = 2* (feet * vol tubing + vol pump): ___________ Starting PSI = (½ WL + 20): ___________
Tubing vol = 0.03L/ft, Bladder pump vol = 0.5L]

3-Volume Purge Sampling

Total Depth (TD): ___________ ft below MP Water Height (H): ___________ ft below MP Casing Radius (r): ___________ ft

Three Purge Volumes = 3*[Pi * r^2 * H * 7.48]: ___________ gal Required Run Time: _______ min/ hr
H= TD-WL, Pi=3.1415, 1gal = 3.785L, 4in casing=0.653gal/ft, 6in casing = 1.469gal/ft

STABILIZATION READINGS

Time (24 Hr)	Water Level (ft below MP)	Purge Rate (gal or L/min)	Cumulative Purge Vol (gal or L)	Temp (C)	pH	ORP/Eh (mv)	DO (mg/L)	Specific Conductivity (µS/cm)	Turbidity (NTU)
Stabilization Limit	+/- 0.3 ft	Low flow ≤ 1L 3-vol = no limit	2 tube vol or 3 well vol	+/- 1C	+/- 0.1	+/- 10	+/- 0.2	+/- 3%	≤ 5

Continue stabilization readings on additional pages if necessary

FINAL READINGS

Time (24 Hr)	Water Level (ft below MP)	Purge Rate (gal or L/min)	Cumulative Purge Vol (gal or L)	Temp (C)	pH	ORP/Eh (mv)	DO (mg/L)	Specific Conductivity (µS/cm)	Turbidity (NTU)

SAMPLE ID: ___________ **TIME:** ___________

Final Low Flow Sampling Settings: PSI: ___________ Charge: ___________ sec Exhaust: ___________ sec

WELL SAMPLING FORM
Continued Stabilization Readings

Page: _____ of _____

Project No.: ________________ Client: P4________________ Date: ______________ Well ID: ______________

STABILIZATION READINGS									
Time (24 Hr)	Water Level (ft below MP)	Purge Rate (gal or L/min)	Cumulative Purge Vol (gal or L)	Temp (C)	pH	ORP/Eh (mv)	DO (mg/L)	Specific Conductivity (µS/cm)	Turbidity (NTU)
Stabilization Limit	+/- 0.3 ft	Low flow ≤ 1L 3-vol = no limit	2 tube vol or 3 well vol	+/- 1C	+/- 0.1	+/- 10	+/- 0.2	+/- 3%	≤ 5

APPENDIX A-3

GROUNDWATER LEVEL DATA COLLECTION

SOP-5

Groundwater Level Data Collection

1.0 PURPOSE

The purpose of this technical procedure is to establish a uniform and consistent procedure for measuring water levels in wells, piezometers and boreholes.

The groundwater level measurement procedures presented in the following sections were developed using standard industry-accepted practices, as well as international organization and agency guidelines and standard practices. The same care must be exercised in implementing field investigations and sampling events that are exercised in planning the program design and analyzing samples in the laboratory. No analytical result is better than the sample from which it was obtained.

Specific organizations and agencies with guidelines and standard procedures that were used include:

- U.S. Environmental Protection Agency (EPA)
- State of Nevada (U.S.) Division of Environmental Protection (NDEP)
- American Society of Testing and Materials (ASTM)

2.0 DEFINITIONS

2.1 Electric Water Level Sounder (EWS)

An electronic water-level sounder (EWS) is an instrument for measuring water levels in wells, piezometers and boreholes. An EWS is essentially an open circuit involving an ammeter and battery mounted on a reel to which an insulated two-wire electric cord (calibrated by length) is wound. The circuit is closed, and a buzzer sounds when the electrodes on the probe are immersed in water. Depth to water is recorded at the depth where the buzzer sounds.

3.0 DISCUSSION

Measurement of static water levels may constitute a separate task or be performed in conjunction with groundwater sampling. Prior to any purge sampling activity at each monitor well, a water level measurement is required to be taken. Measurement of the static water level is important in determining the hydrogeologic characteristics of the groundwater system.

Prior to taking the EWS to the field, check that the EWS is functioning properly and that the batteries are in working order by turning instrument on and pushing the test button located on the side of the instrument. Also verify that the probe is functioning properly by submerging it in tap water. Both the audio and visual signals should function.

Decontaminate the probe and cord of the EWS using Alconox or equivalent non-phosphate detergent and distilled water. Rinse a minimum of three (3) times with distilled water. At a minimum decontaminate the probe and the length of reel you believe will be in the well plus an additional 3 meters.

The measurement will be referenced from the reference point marked on the top of the well casing; this is typically located on the north side of the casing. The measurement to the static water level in the well will be to the nearest 0.01-foot interval. The measurement will be immediately repeated to verify the accuracy of the initial reading. The depth to water measurement will be compared in the field to previous measurements to verify that the measurement is reasonable. Record the depth to water level on the field logbook and Record of Water Level Readings form (see Appendix A). Other items to record include well identification number, casing diameter, vertical height of measuring point above ground surface, and time and date of measurement.

If depth to water is measured in an open borehole, note that the reference level is ground surface. Also note, especially if the ground is uneven, from which side of the borehole (i.e. north, etc.) the measurement was referenced.

In addition, it is good practice to periodically measure total well depth, since silt can build up and decrease the total depth of the well. Measure the total depth of the well following determination of static water level. If using the EWS to determine the depth of the well, make sure that the additional cable that will be submerged has been decontaminated and that the probe tip length is added to the total depth measured. Total well depth measurement also ensures that the well is in good condition to total depth.

4.0 EQUIPMENT AND MATERIAL

The following is a list of equipment that should be available in the field to perform water level measurements.

- Electric Water-level Sounder or Measuring Tape with a Wetable Surface
- Folding Rule
- Field logbook or field data sheet (see Record of Water Level Readings form, found in Appendix A)
- Data on Well Identification Number and Locations
- Spare Battery for Electric Water-level Meter
- Permanent, waterproof pens

5.0 PROCEDURES

- Record well identification number and measuring device type and serial number.

- Each water level sounder or measuring tape used for recording water levels should have the depth graduations checked with an independent folding rule or measuring tape for calibration prior to field use.

- Clean all downhole instruments and equipment before and after measurements between wells. Cleaning should be with a non-phosphate detergent rinse followed by a rinse with approved tap water, then rinse with organic free distilled or deionized water.
- Measure and record distance from ground level to top of casing or standpipe. Measure the vertical distance from the top of casing or standpipe to the point of the elevation survey mark (if different from top of casing or standpipe).

- If an EWS is used, turn on the EWS, check the battery, lower the wire into the borehole or standpipe and stop at the depth where the EWS meter indicates a repeatable, completed circuit. Record the length of the wire below the casing collar or top of the standpipe to the nearest 0.01-foot.

- If a measuring tape is used, lower the tape (with a weight attached) into the borehole. The tape must be lowered a sufficient depth into the well to ensure the wetable surface section of the tape is partially submerged. The total length of the tape within the well (from the top of casing or standpipe) and the length of the wetted surface to the submerged end of the tape will be recorded.

- Record date, time, well designation, measuring device and all measurements on a Record of Water Level Readings form (Appendix A), and bound logbook. The personnel making the measurement will initial or sign each measurement recorded. All water level measurement records will be maintained in the project records files.

6.0 REFERENCES

American Society of Testing and Materials (ASTM). 1994. *Standards on Ground Water and Vadose Zone Investigations*. Second Edition. ASTM Committee D-18 on Soil and Rock. Philadelphia, Pa.

American Society of Testing and Materials (ASTM), 1995. *ASTM Standards on Environmental Sampling*. PCN-03-418095-38, Philadelphia, Pa.

U.S. Environmental Protection Agency (EPA), 1994. *Standard Operating Procedures for Field Sampling Activities, Version 2*. EPA Region VIII, Denver, Colorado.

U.S. Environmental Protection Agency (EPA), 1995. *Standard Operating Procedures for Water Level and Non-Aqueous Phase Liquid (NAPL) Measurements in Boreholes and Monitoring Wells, Version 1*. EPA Region VIII, Denver, Colorado.

APPENDIX A-4

TRENCHING AND TEST PITTING

STANDARD OPERATING PROCEDURES

SOP-8
TRENCHING AND TEST PITTING

Stantec

STANDARD OPERATING PROCEDURES

SOP-8
TRENCHING AND TEST PITTING

TABLE OF CONTENTS

DISCLAIMER

THE FOLLOWING STANDARD OPERATING PROCEDURE PROVIDE A GENERAL GUIDANCE ON INTERNAL PROCEDURES OF STANTEC, INC. ("STANTEC") RELATING TO TECHNICAL ISSUES TO BE ADDRESSED INVOLVING EXCAVATION AND SAMPLING OF ENVIRONMENTAL TEST PITS. IT IS NOTED, HOWEVER, THAT EACH PROJECT AND SITE IS UNIQUE AND THAT THESE GUIDELINES ARE NOT A SUBSTITUTE FOR COMMON SENSE AND GOOD MANAGEMENT PRACTICES BASED ON PROFESSIONAL TRAINING AND EXPERIENCE. IN ADDITION, INDIVIDUAL CONTRACT TERMS MAY AFFECT THE IMPLEMENTATION OF THESE STANDARD OPERATING PROCEDURES. MANAGEMENT RESERVES THE UNRESTRICTED RIGHT TO CHANGE, MODIFY OR NOT APPLY THESE GUIDELINES IN ITS SOLE, COMPLETE AND UNRESTRICTED DISCRETION TO MEET CERTAIN CIRCUMSTANCES, CONTRACTUAL REQUIREMENTS, SITE CONDITIONS OR JOB REQUIREMENTS.

1.0 INTRODUCTION

This standard operating procedure establishes guidelines for conducting test pit and trench excavations at hazardous waste sites.

Shallow test pits accomplish the following:

- Permit the in-situ condition of the ground to be examined in detail both laterally and vertically
- Provide access for taking samples and for performing in-situ tests
- Provide a means of determining the orientation of discontinuities in the ground

Periodically, a portion of a site investigation will focus on abandoned subsurface structures or an area that may contain, or was at one time a dumping ground for, various types of hazardous and nonhazardous waste. Before drilling soil borings in these areas, excavation of a trench or test pit may be necessary to clear drilling areas of debris and identify sources or geophysical anomalies. Excavations can be readily extended to locate the boundaries of abandoned foundations, landfills, or trenches. At appropriate locations, trenches or test pits may be used to uncover unexploded ordnance by qualified explosive ordnance detection teams prior to commencing any intrusive activities. In suitable ground, shallow excavations may provide an efficient and economic method to evaluate the shallow subsurface environment of a site.

2.0 DEFINITIONS

Trench or Test Pit	Linear excavation, of varying width, usually used as an exploratory method to locate landfill boundaries or buried structures, or to characterize the soil/fill sequence at a site.
Ground Crew	Composed of excavating support crew and sampling crew.

3.0 RESPONSIBILITIES

The **Project Manager** selects site-specific soil sampling methods with input from the Site Geologist/Field Team Leader and oversees preparation of heavy equipment/explosive ordnance detection subcontract.

The **Site Geologist/Field Team Leader** selects excavation options, implements the trenching/test pit program, assists in the preparation of technical provisions, and prepares subcontracts.

The **Sampling Crew** performs sampling procedures.

4.0 TRENCH AND TEST PIT CONSTRUCTION

4.1 GENERAL

Trench and test pit excavation is carried out either manually or by using standard equipment such as backhoes, trenching machines, track dozers, track loaders, excavators, and scrapers. Operators of excavating equipment must be skilled and experienced in its safe use for digging test pits and trenches. A typical excavator with an extending backhoe arm can excavate to a depth of approximately 15 feet. If investigations are required to penetrate beyond 15 feet, soil borings may be a more feasible method.

A tailgate safety meeting is conducted by a designated on-site safety officer before commencing excavation.

Prior to all excavations, the Field Team Leader must confirm that underground utilities (electric, gas, telephone, water, etc.) within the proposed areas of excavation have been cleared or marked off. Certain underground services may not be picked up by detectors. Careful excavation, use of probing rods, and the ground crew watching for early signs can help prevent damaging or puncturing underground services.

Prior to commencing excavation, standard signals shall be developed and reviewed for rapid and efficient communication between the backhoe operator and the ground crew. Before approaching areas with operating equipment, the sampling and support crew must verify that the operator has noted their presence.

Upon locating the area for excavation, the backhoe operator determines wind direction and positions the machine upwind of the area of excavation. The backhoe operator outlines the area of investigation by extending the bucket arm to its maximum length and traces a 180-degree outline around the area to be excavated. The support crew cordons off the exclusion zone with a wooden lath and brightly colored "caution" tape, or other appropriate temporary fencing.

Once the excavation equipment has been positioned and stabilized, excavation can commence. If the area of investigation is beneath vegetative cover or surface debris, the backhoe operator removes the surface material to allow a clear and safe working area. Excavated soil is stockpiled away from the immediate edge to one side of the trench to prevent excavated soil from re-entering the trench or test pit and to reduce pressure on the sidewalls. When possible, the soil is deposited downwind of the ground crew and the machine operator. Shifting winds may cause the machine and its operator and the ground crew to periodically move in order to remain upwind. Under some conditions where remaining upwind is not possible, it may be necessary to curtail further activities. The support crew should regularly check the machine operator who, if in a partially enclosed cabin, may be susceptible to fumes/gases.

4.1.1 Safety Procedures

Entry of personnel into pits or trenches is strictly prohibited unless specifically approved and strict adherence to state and federal Occupational Safety and Health Administration guidelines is observed.

Unless full lateral support of the side walls is provided, personnel should never trench deeper than 4 feet (chest height) when personnel will be working in the trench. Any personnel entering the trench may be exposed to toxic or explosive gases and an oxygen-deficient environment. Air monitoring is required before and during entry and appropriate respiratory gear, protective clothing, and egress/rescue equipment is mandatory. Caution should be exercised at all times. For example, in combustible fills, temperature measurements may be necessary. On waste tips, burning material below ground may give rise to toxic or flammable fumes from the hole; tip fires may also create voids that may collapse under the weight of an investigation rig or backhoe machine. Lagoons within waste tips may be areas of very soft ground.

At least two people must be present at the immediate site. Ladder access/egress out of the pit must be installed before entry. Two ladders for worker access/egress must be provided for every 25 feet of lateral distance of a trench and, at a minimum, ladders shall be positioned at opposite ends of trenches less than 25 feet in length.

Care should be taken to ensure that personnel do not stand too close to the edge of the trench especially during sampling or depth measurements; the combination of depositing soil adjacent to the pit and the risk of caving or toppling of the side walls in unstable soils can lead to unsafe conditions.

4.1.2 Stability

Depending on the desired depth of excavation, the trench may require shoring to prevent the sides from collapsing. Lateral support may be provided by a support frame system, or by benching or sloping the sides of the excavation or trench to an appropriate angle. Any timbering or support systems must be installed by qualified personnel.

Groundwater may be pumped out of the pit to stabilize the sidewalls and to keep the excavation dry, allowing a greater depth to be reached especially in granular materials that are below the water table.

Near-vertical slopes can stand for seconds or months, depending on the types of material involved and various other factors affecting the stability. Although personnel should not be entering the excavation, it is prudent to know the possible behavior of the various soil types and conditions that may be encountered. Excavations into fill are generally much more unstable than those in natural soil.

Excavations in very soft, normally consolidated clay may stand vertically without support for short periods. Long-term stability is dependent on a combination of factors: the type of soils, pore pressures, and other forces acting within the soil, and adverse weather effects. Fissured clays can fail along well-defined shear planes; therefore, their long-term stability is not dependent on their shear strength and is difficult to predict.

Dry sands and gravels can stand at slopes equal to their natural angle of repose no matter what the depth of the excavation (angles can range from approximately 28 to 46 degrees depending on the angularity of grains and relative density).

Damp sands and gravels possess some cohesion and can stand vertically for short periods. Water-bearing sands, however, are very difficult in open excavations. If they are cut steeply, as in trench excavation, seepage of water from the face will result in erosion at the toe followed by collapse of the upper part of the face until a stable angle of approximately 15 to 20 degrees is obtained.

Dry silts may stand unsupported vertically, especially if slightly cemented. Wet silt is the most troublesome material to excavate. Seepage leads to slumping and undermining with subsequent collapse, eventually reaching a very shallow angle of repose.

It should not be taken for granted that excavations in rock will stand with vertical slopes unsupported. Their stability depends on the soundness, angle of bedding planes, and the degree of shattering. Unstable conditions can occur if bedding planes slope steeply towards the excavation, especially if groundwater is present to act as lubrication.

4.2 FIELD RECORDING AND SAMPLING TECHNIQUES

The field record should include a plan giving the location, dimensions, and orientation of the pit, together with dimensioned sections of the sidewalls, description of the strata encountered, and details of any sampling or testing carried out. A photographic record of the test pit, with an appropriate scale, would be ideal.

Any groundwater encountered should be noted with regard to its depth and approximate rate of seepage. If possible, the groundwater level within the test pit should be monitored for 20 minutes, with readings taken at 5-minute intervals.

Working from the ground surface the technician can prepare a visual log of the strata/soil profile and decide the interval of sampling. Samples from excavations can be either disturbed or undisturbed.

Disturbed samples are taken from the excavator bucket or from the spoil. To obtain a representative sample of the material at a certain depth, care must be taken not to include scrapings from the sidewalls.

Undisturbed samples may be block samples, cut from in situ material; tube samplers may be driven into the floor of the pit using a jarring link and drill rods and extracted using the backhoe of the excavator.

Samples of groundwater or leachate may be taken using telescoping poles or a small bailer.

The required size of the samples will vary according to the intended analysis/testing to be carried out.

4.3 BACKFILLING

The test pits or trenches should be backfilled immediately upon completion of the hole. Prior to backfilling, pits and test trenches should be inspected to make sure it is safe to approach the excavation with the backfill and equipment. Poorly compacted backfill will cause settlement at the ground surface and hence the spoil should be recompacted in several thin layers using the excavator bucket and any surplus material placed over the top of the pit.

If a sealing layer has been penetrated during excavation, resulting in a groundwater connection between contaminated and previously uncontaminated zones, the backfill material must represent the original conditions or be impermeable. Backfill material could comprise a soil-bentonite mix or a cement-bentonite grout.

4.4 DECONTAMINATION

The purpose of decontamination and cleaning procedures during sampling tasks is to prevent foreign contamination of the samples and cross contamination between sites. All sampling and excavation equipment must be decontaminated before use.

5.0 REFERENCES

Scientific and Technical Standards for Hazardous Waste Sites, Book 1, Volume 1, Site Characterization, August 1990.

Tomlinson, M.J., 1986. *Foundation Design and Construction*, 5th Edition.

TRENCH TEST PIT LOG FORM

Page _____ of _____

Project ________________________ **Project Number** ________________________

Sample Location ________________________ **Trench Number** ________________________ **Date** ________________

Coordinates: Inside Stake ________________________ **Outside Stake** ________________________

Native/Fill Stake ________________________

Logged By ________________________

TRENCH PROFILE

Depth in Feet

Feet

Subsurface description and filed USCS Classifications
(USCS name, color, size and angularity or plasticity, density, moisture content, additional facts and debris encountered)

____

____

____

____

____

____

____

____

____

Begin Trench ________________ **Finish Trench** ________________ **Trenching Contractor** ________________

Total Depth ________________ **Total Length** ________________

APPENDIX B

QAPP PROCEDURES

APPENDIX B-1

SEQUENTIAL EXTRACTION PROCEDURE

Sequential Extraction Procedure for the Speciation of Particulate Trace Metals

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Correlation of Electron Capture Response Enhancements Caused by Oxygen with Chemical Structure for Chlorinated Hydrocarbons

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APPENDIX B-2

HACH FERROUS IRON METHOD

Iron, Ferrous

DOC316.53.01049

1,10-Phenanthroline Method[1]

Method 8146

0.02 to 3.00 mg/L Fe^{2+}

Powder Pillows or AccuVac® Ampuls

Scope and application: For water, wastewater, seawater, brine solutions, produced waters and hydraulic fracturing waters.

[1] Adapted from Standard Methods for the Examination of Water and Wastewater, 15th ed. 201 (1980).

Test preparation

Instrument-specific information

Table 1 shows sample cell and orientation requirements for reagent addition tests, such as powder pillow or bulk reagent tests. Table 2 shows sample cell and adapter requirements for AccuVac Ampul tests. The tables also show all of the instruments that have the program for this test.

To use the table, select an instrument, then read across to find the applicable information for this test.

Table 1 Instrument-specific information for reagent addition

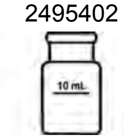
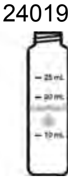
Instrument	Sample cell orientation	Sample cell
DR 6000 DR 3800 DR 2800 DR 2700 DR 1900	The fill line is to the right.	2495402 
DR 5000 DR 3900	The fill line is toward the user.	
DR 900	The orientation mark is toward the user.	2401906 

Table 2 Instrument-specific information for AccuVac Ampuls

Instrument	Adapter	Sample cell
DR 6000 DR 5000 DR 900	—	2427606 
DR 3900	LZV846 (A)	
DR 1900	9609900 or 9609800 (C)	
DR 3800 DR 2800 DR 2700	LZV584 (C)	2122800 

Before starting

Samples must be analyzed immediately after collection and cannot be preserved for later analysis.
Install the instrument cap on the DR 900 cell holder before ZERO or READ is pushed.
For the best results, measure the reagent blank value for each new lot of reagent. Replace the sample with deionized water in the test procedure to determine the reagent blank value. Subtract the reagent blank value from the sample results automatically with the reagent blank adjust option.
Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.
Dispose of reacted solutions according to local, state and federal regulations. Refer to the Safety Data Sheets for disposal information for unused reagents. Refer to the environmental, health and safety staff for your facility and/or local regulatory agencies for further disposal information.

Items to collect

Powder pillows

Description	Quantity
Ferrous Iron Reagent Powder Pillows, 25-mL	1
Sample cells. (For information about sample cells, adapters or light shields, refer to Instrument-specific information on page 1.)	2

Refer to Consumables and replacement items on page 6 for order information.

AccuVac Ampuls

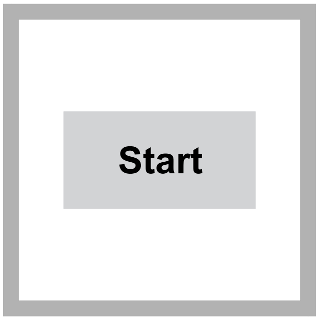
Description	Quantity
Ferrous Iron Reagent AccuVac Ampuls	1
Beaker, 50-mL	1
Sample cells (For information about sample cells, adapters or light shields, refer to Instrument-specific information on page 1.)	1
Stopper for 18-mm tubes and AccuVac Ampuls	1

Refer to Consumables and replacement items on page 6 for order information.

Sample collection

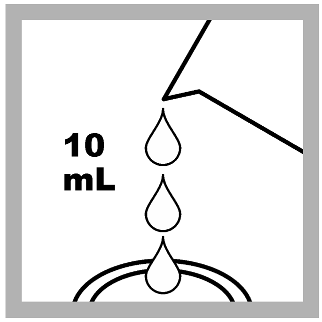
- Samples must be analyzed immediately after collection and cannot be preserved for later analysis.
- Collect samples in clean glass or plastic bottles with tight-fitting caps. Completely fill the bottle and immediately tighten the cap.
- Prevent agitation of the sample or exposure to air.

Powder pillow procedure

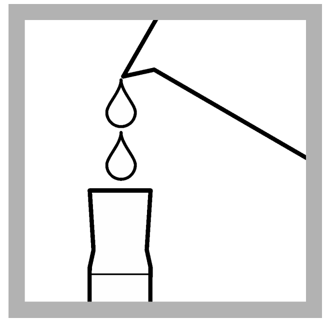


1. Start program **255 Iron, Ferrous**. For information about sample cells, adapters or light shields, refer to Instrument-specific information on page 1.

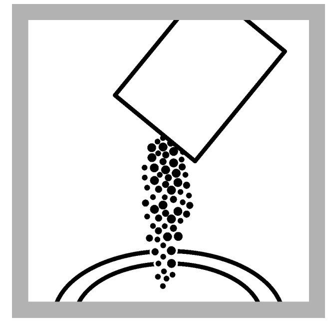
Note: *Although the program name can be different between instruments, the program number does not change.*



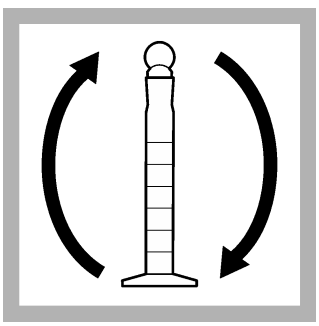
2. Prepare the blank: Fill the sample cell with 10 mL of sample.



3. Prepare the sample: Fill a mixing cylinder to the 25-mL line with sample.

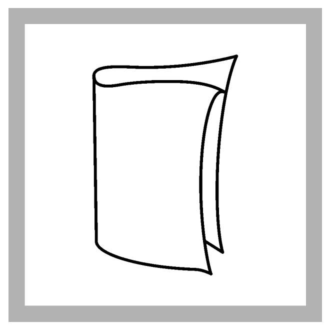


4. Add the contents of one Ferrous Iron Reagent Powder Pillow to the mixing cylinder.
An orange color shows if ferrous iron is present in the sample



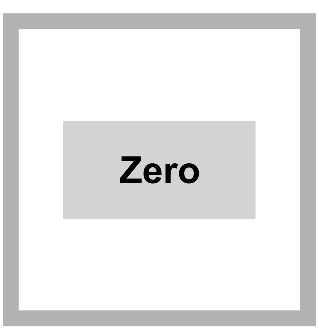
5. Put the stopper on the mixing cylinder. Invert the mixing cylinder several times to mix.
Undissolved powder does not affect accuracy.

6. Start the instrument timer. A 3-minute reaction time starts.

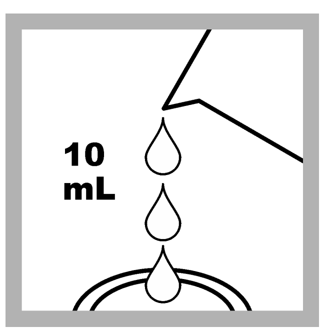


7. When the timer expires, clean the blank sample cell.

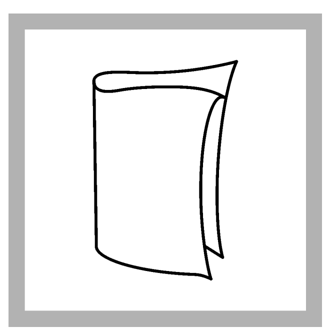
8. Insert the blank into the cell holder.



9. Push **ZERO**. The display shows 0.00 mg/L Fe^{2+}.

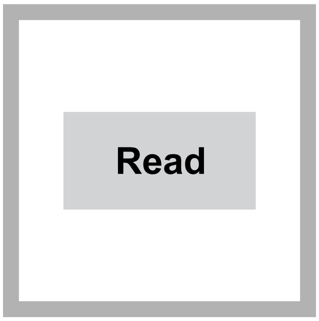


10. Fill a second sample cell with 10 mL of the reacted prepared sample.



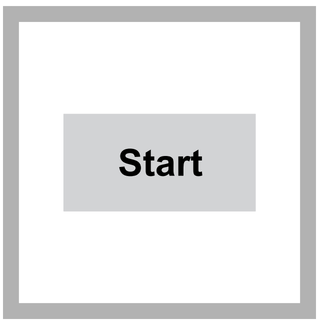
11. Clean the prepared sample cell.

12. Insert the prepared sample into the cell holder.



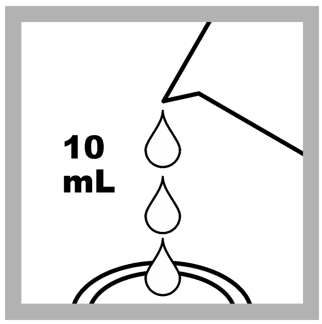
13. Push **READ**. Results show in mg/L Fe^{2+}.

AccuVac Ampul procedure



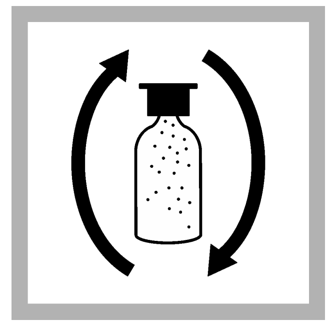
1. Start program **257 Iron, Ferrous AV**. For information about sample cells, adapters or light shields, refer to Instrument-specific information on page 1.

Note: *Although the program name can be different between instruments, the program number does not change.*



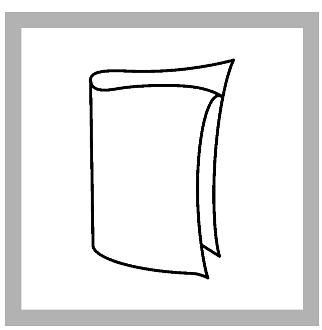
2. Prepare the blank: Fill the sample cell with 10 mL of sample.

3. Prepare the sample: Collect at least 40 mL of sample in a 50-mL beaker. Fill the AccuVac Ampul with sample. Keep the tip immersed while the AccuVac Ampul fills completely.



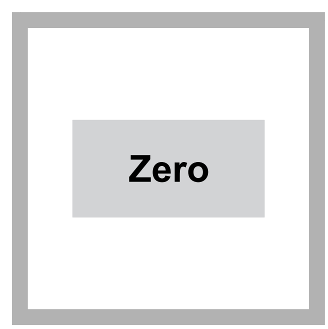
4. Quickly invert the AccuVac Ampul several times to mix.

5. Start the instrument timer. A 3-minute reaction time starts.

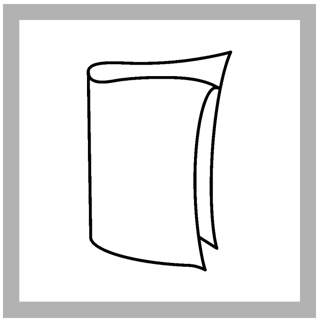


6. When the timer expires, clean the blank sample cell.

7. Insert the blank into the cell holder.

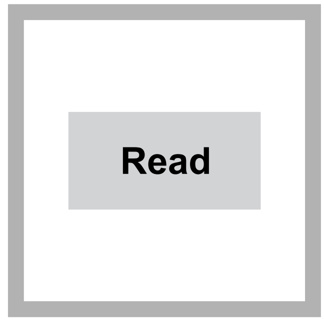


8. Push **ZERO**. The display shows 0.00 mg/L Fe^{2+}.



9. Clean the AccuVac Ampul.

10. Insert the prepared sample AccuVac Ampul into the cell holder.



11. Push **READ**. Results show in mg/L Fe^{2+}.

Accuracy check

Standard solution method

Use the standard solution method to validate the test procedure, the reagents and the instrument.

Items to collect:

- Ferrous Ammonium Sulfate, hexahydrate
- 1-L volumetric flask, Class A
- 100-mL volumetric flask, Class A
- 2-mL volumetric pipet, Class A and pipet filler
- Deionized water

1. Prepare a 100-mg/L Fe^{2+} ferrous iron stock solution as follows:
   - **a.** Add 0.7022 g of ferrous ammonium sulfate, hexahydrate into a 1-L volumetric flask.
   - **b.** Dilute to the mark with deionized water. Mix well.
2. Prepare a 2-mg/L ferrous iron standard solution as follows:
   - **a.** Use a pipet to add 2.00 mL of the 100-mg/L Fe^{2+} ferrous iron stock solution into a 100-mL volumetric flask.
   - **b.** Dilute to the mark with deionized water. Mix well. Prepare the standard solution immediately before use.
3. Use the test procedure to measure the concentration of the prepared standard solution.
4. Compare the expected result to the actual result.

   ***Note:** The factory calibration can be adjusted slightly with the standard adjust option so that the instrument shows the expected value of the standard solution. The adjusted calibration is then used for all test results. This adjustment can increase the test accuracy when there are slight variations in the reagents or instruments.*

Method performance

The method performance data that follows was derived from laboratory tests that were measured on a spectrophotometer during ideal test conditions. Users can get different results under different test conditions.

Program	Standard	Precision (95% Confidence Interval)	Sensitivity Concentration change per 0.010 Abs change
255	2.00 mg/L Fe^{2+}	1.99–2.01 mg/L Fe^{2+}	0.021 mg/L Fe^{2+}
257	2.00 mg/L Fe^{2+}	1.98–2.02 mg/L Fe^{2+}	0.023 mg/L Fe^{2+}

Summary of method

The 1,10-phenanthroline indicator in the Ferrous Iron Reagent reacts with ferrous iron (Fe^{2+}) in the sample to form an orange color in proportion to the iron concentration. Ferric iron (Fe^{3+}) does not react. The ferric iron concentration can be determined by subtracting the ferrous iron concentration from the results of a total iron test. The measurement wavelength is 510 nm for spectrophotometers or 520 nm for colorimeters.

Consumables and replacement items

Required reagents

Description	Quantity/test	Unit	Item no.
Ferrous Iron Reagent Powder Pillow, 25-mL	1	100/pkg	103769
OR			
Ferrous Iron Reagent AccuVac® Ampul	1	25/pkg	2514025

Required apparatus

Description	Quantity/test	Unit	Item no.
Beaker, 50-mL	1	each	50041H
Stoppers for 18-mm tubes and AccuVac Ampul	1	6/pkg	1448000

Recommended standards and apparatus

Description	Unit	Item no.
Balance, analytical, 80 g x 0.1 mg 100–240 VAC	each	2936701
Ferrous Ammonium Sulfate, hexahydrate, ACS	113 g	1125614
Flask, volumetric, Class A, 1000-mL glass	each	1457453
Pipet filler, safety bulb	each	1465100
Pipet, volumetric, Class A, 1.00-mL	each	1451535
Water, deionized	4 L	27256
Wipes, disposable	280/pkg	2097000

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APPENDIX C

HEALTH AND SAFETY PLAN (HASP)

Ballard Mine Site – P_4 Production
Remedial Investigation /
Feasibility Study
Health and Safety Plan

Prepared for:
P_4 Production

Prepared by:
Stantec Consulting Services Inc.

April 6, 2018

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ACRONYMS AND ABBREVIATIONS

ACGIH	American Congress of Governmental Industrial Hygienists
ANSI	American National Standards Institute
CFR	Code of Federal Regulations
CPR	Cardiopulmonary Resuscitation
EMS	Environmental Management System
EPA	Environmental Protection Agency
ft	Feet
FTL	Field Team Leader
HASP	Health and Safety Plan
HSSE	Health, Safety, Security and Environmental
IDLH	Immediately Dangerous to Life or Health
IMASC	Idaho Mining Association Selenium Committee
JRA	Pre-Job Risk Analysis
MSDS	Material Safety Data Sheet
MSHA	Mine Safety and Health Administration

NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NPS	National Parks Service
OSEC	Office Safety and Environmental Coordinator
OSHA	Occupational Safety and Health Administration
OHSMS	Occupational Health and Safety Management System
PEL	Permissible Exposure Limit
PPE	Personal Protective Equipment
PSO	Project Safety Officer
REL	Recommended Exposure Limit
RI/FS	Remedial Investigation and Feasibility Study
SDS	Safety Data Sheet (Global Harmonization version of the MSDS)
SOP	Standard Operating Procedure
SSHO	Site Safety and Health Officer
TLV	Threshold Limit Value
TWA	Time-Weighted Average
yds	Yards

1.0 INTRODUCTION

This Health and Safety Plan (HASP) has been prepared by Stantec for the ***P_4 Production, Remedial Investigation/Feasibility Study (RI/FS)*** project. The project is being performed under contract with ***P_4 Production*** *(a subsidiary of Monsanto)*. Stantec does not have responsibility for initiating, maintaining, monitoring, supervising, or determining the adequacy or implementation of the safety precautions, programs, or plans of ***P_4 Production*** as the Client or of any other contractor which the Client elects to directly employ. The information in this HASP should not be used for advising, issuing direction, or assuming control over any safety precautions or programs of ***P_4 Production***.

Where this HASP addresses safe practices for various specific activities, this information is provided solely as directives or guidelines for protecting Stantec employees (including "employee like" sub consultant employees that are supervised by Stantec on a day-to-day basis) and establishing minimum requirements for Stantec Subcontractors. Any questions over implementation of this plan should be addressed to the designated project Site Safety and Health Officer (SSHO) or the Stantec Health, Safety, Security and Environment Manager (HSSE) or their designee.

Stantec Subcontractors are contractually responsible for assuring the safety and health of their own employees. Any precautions, programs or HASP of any Stantec Subcontractor must, at a minimum, meet the requirements of this HASP. However, this HASP is not intended to in any way be a substitute for any subcontractor's own risk analysis or to otherwise relieve any subcontractor of any applicable contractual and regulatory responsibilities and requirements for health and safety. Stantec Subcontractor's provided this HASP shall acknowledge that it is only intended as minimum HASP requirements, and shall provide their own HASP, including any changes or revisions specific to their activities and scope of work.

1.1 HEALTH AND SAFETY PLAN OBJECTIVE

This HASP is issued by Stantec to establish the work practices necessary for the protection of Stantec employees during the performance of their work activities. The scope of services for Stantec work activities is summarized in section 2.1.

The objective of this HASP is to address known and reasonably anticipated health and safety hazards to the Stantec employees providing services under Stantec's contract with ***P_4 Production*** for the ***P_4 Production RI/FS*** project. In particular, this HASP provides general and specific information designed to prevent and minimize personal injuries, illnesses to any Stantec employees and physical damage to equipment, supplies and property. Stantec requires Stantec Subcontractors to have their own HASP. The Stantec Subcontractor's HASP must at least meet the minimum requirements within this HASP.

All project activities will be performed in accordance with applicable Stantec requirements, as well as agencies responsible for regulating industrial health and safety, including the OSHA and MSHA. Furthermore, P_4 Production employs its own practice of training every contractor that works on the P_4 mine sites to ensure that everyone on the site is knowledgeable and aware of hazards that exist. This process and the applicable documents are discussed where applicable in this HASP. All Stantec employees and visitors must comply with the requirements of this HASP.

1.2 HSSE POLICY

Policy

Stantec is committed to providing and maintaining a healthy, safe, and secure workplace for our staff, clients, partners, and subcontractors and to responsibly managing all the environmental aspects of its business

Practice

Our core company values guide us in all that we do. The way we treat our people, our clients, and our neighbors reflects who we are, what we believe in, and how we do our work. At Stantec, we believe in doing what is right and being Safer Together, which includes zero harm to the environment and sending our people home injury-free, every day.

Stantec's Health, Safety, Security, and Environment (HSSE) Program is a cornerstone of the Occupational Health and Safety Management System (OHSMS) and the Environmental Management System (EMS). In turn, these Management Systems are part of Stantec's overall Integrated Management System.

Stantec strives to

- Visibly demonstrate a commitment to HSSE by providing responsible leadership, and clearly communicating expectations.
- Assist and support employees in developing an awareness and understanding of the health, safety, security, and environmental issues related to their work.
- Identify, assess, and manage the health, safety, security and environmental hazards and risks to which its employees are exposed
- Minimize the environmental aspects and impacts associated with the services and products it provides
- Comply with legislation, regulations, and appropriate industry standards
- Monitor and enhance the health, safety, security and environmental practices through inspections, audits, reviews, investigations, corrective actions, shared learnings, review of best practices, and behavior-based processes
- Share lessons learned and integrate best HSSE practices into our businesses
- Provide a framework which supports the continual improvement of the system
- Work collaboratively with employees to achieve health, safety, security, and environmental objectives, at work and at home
- Foster a culture of being Safer Together, in which all employees, partners, and subcontractors share a commitment to health, safety, security, and the environment.

Everyone working for Stantec is responsible and accountable for Stantec's health, safety, security and environmental performance. Management, supervisors, employees, and subcontractors are expected to understand their roles and responsibilities as outlined by the HSSE Program and to comply with the practices of the Occupational Health and Safety Management System, and the Environmental Management System.

1.3 EMPLOYEE EMPOWERMENT

Employees are Stantec's most valuable asset; their safety is of vital concern. If at any time, if a Stantec employee or contractor feels an unsafe condition, they have not only the authority, but ALSO the responsibility to call for "Stop Work" until safe methods are developed and implemented. It is the intent on this project for employees to accept responsibility and ownership of the HSSE Program. This HASP is a living document, and the goal of Stantec is that employees are involved in the development and evolution of the HASP.

1.4 SAFETY MANAGEMENT

The objective of safety management is to integrate safety, health, and environmental protection into all work practices. Stantec will accomplish this objective by involving all employees in the work planning process, development of the HSSE Program, and development and updating of procedures. The HSSE program is tailored to project specific activities and is critical to the success of this project.

1.5 MODIFYING THE HEALTH AND SAFETY PLAN

This HASP and associated Activity Hazard Analysis must be modified if, new hazards are identified, the scope of work is revised, or the provisions specified in the HASP are not adequate to protect the health and safety of all personnel. Modifications will be accomplished by consultation with all project Health and Safety personnel, who in turn shall recommend appropriate modifications after approval by the Stantec's Manager of HSSE or designee. All changes to the HASP shall be documented with the appropriate revision number. The Manager of HSSE or designee and the Project Manager must approve the changes to this document. This process is to be documented in the HASP and the project files. The Project Manager will be responsible for informing staff and Stantec Subcontractors of all changes.

1.6 H&S TRAINING FOR PROJECT WORK AND SITE ACCESS

Stantec will provide its employees with the proper training required for their work activities. At a minimum any Stantec employee performing work on the site must be familiar with the requirements of this HASP, including the emergency contact information. Project/site-specific training requirements are set forth in Section 5 of this HASP and completion will be documented using the Acknowledgement Form (Appendix B). Stantec visitors will be briefed in accordance with Section 3.2.5.

1.7 STANTEC SUBCONTRACTORS SITE HEALTH AND SAFETY PLAN

Stantec Subcontractors are responsible for preparing a project specific Health and Safety Plan as applicable to their scope of work. Their HASP shall be acceptable to Stantec. Their HASP shall provide for the means and methods to identify hazards, implement controls, and enforce the precautions and requirements for ensuring the health and safety its employees and property. At a minimum, the Stantec Subcontractor must meet the requirements of this HASP.

1.8 STANTEC INJURY AND ILLNESS PREVENTION PLAN

It is the policy of Stantec and the management organization of field projects to provide a safe and healthful work environment for all assigned employees. Stantec recognizes that injury, illness, or property/equipment loss impacts each of our lives through suffering and potential disability, as well as through lost wages and productivity.

A fundamental principle of industrial safety and loss prevention is that most accidents that cause injuries or illnesses and property damage are preventable. Examinations of the causes of accidents and industrial illnesses demonstrate that most injuries or illnesses are the result of an unsafe act or condition. Stantec recognizes that it is both a moral obligation and a sound business practice to prevent workplace injuries and illnesses.

These goals can be accomplished by anticipating, recognizing, evaluating and controlling unsafe acts and conditions. Management personnel at all levels shall, through personal example, create a work climate in which all assigned employees develop a concern, not only for their own safety and health, but also for the safety and health of their fellow workers and the environment.

2.0 PROJECT DESCRIPTION, AND SCOPE OF WORK

The Ballard Mine is located approximately 13 miles north-northeast of Soda Springs, Idaho in Caribou County (**Figure 2-1**) and is accessed via the Blackfoot River Road, off State Highway 34. Ballard Mine was in operation between 1952 and 1969 and is comprised of external mine waste dumps, open pits, an abandoned haul road, and the Ballard Shop Area, all of which cover approximately 534 acres of disturbance. P_4 Production, LLC (a subsidiary of Monsanto) owns approximately 865 acres of surface rights and has a surface easement from the State of Idaho on an additional 360 acres. These properties contain all of Ballard Mine. The adjoining properties are all privately held ranching and farming properties. The nearest downstream Federal land is a 40-acre Bureau of Land Management (BLM) parcel approximately one mile southeast of the mine.

Figure 2-1: Ballard Mine Location

This project support the Ballard Site Selected Remedy by further characterizing the: 1) borrow area cover material distribution and properties that will be used for the proposed upland soils/waste rock remedy; 2) chemical properties of the alluvial and Wells Formation aquifers will be collected to support the MNA groundwater remedy component and also will be used for long-term monitoring (LTM); and, 3) shallow alluvial aquifer chemical and physical hydrogeologic properties in the vicinity of the proposed permeable reactive barriers (PRBs) and wetland locations that are planned for treatment of mine-affected seeps and springs as part of the alluvial groundwater and surface water remedies.

Field activities will include drilling, borehole soil sampling, well installation and development, hydraulic conductivity testing, groundwater sampling, test pit excavation, equipment decontamination, handling of investigation derived waste(s), surveying of all boreholes, test pits and monitoring well locations, and proper execution of standard borehole abandonment in accordance with IDAPA 37.03.09 Well Construction Standard Rules.

3.0 PROJECT ROLES AND RESPONSIBILITIES

Stantec is responsible to P_4 Production for verifying that the project activities are carried out in accordance with the agreed upon scope of work and related contract documents. Along with this responsibility, Stantec will verify that Stantec's Project activities are carried out in a manner consistent with applicable health and safety regulations, client HSSE requirements, corporate HSSE procedures, and this HASP. Implementation will be accomplished through an integrated effort of the following personnel:

Table 3-1: Project Health and Safety Program Contact List

Company or Agency	Contact	Title	Telephone
P_4 Production	Molly Prickett	Program Manager	208-547-1439 (work)
Stantec	Chad Tomlinson	Project Manager	801-617-3390 (work) 801-209-6837 (cell)
	Vance Drain	Senior Advisor	801-617-3250 (work) 801-455-2949 (cell)
	Tony Wong	Stantec HSSE Manager	805-250-2860 (work) 805-234-6227 (cell)
	Randy Jones	Stantec HSSE Advisor *HSSE Managers Designee*	303-533-1964 (work) 720-530-7274

			(cell)

The roles of the key individuals from the preceding table are discussed further in the following paragraphs. All individuals involved in the project will review and follow this Health and Safety Plan and will sign the *Personal Acknowledgement Form* in Appendix F.

3.1 VICE PRESIDENT-IN-CHARGE

As the senior management representative for the program, the Vice President-in-Charge is responsible for defining program objectives, allocating resources, establishing the management organization, and evaluating program outcomes. The Vice President-in-Charge, working through the assigned Stantec Program Manager, is ultimately responsible for:

- Providing the facilities, equipment, and budget needed to perform work safely;
- Ensuring adequate personnel and schedule for safe operations;
- Ascertaining appropriate review and distribution of health and safety documents;
- Supporting the efforts of program and field personnel; and,
- Applying appropriate disciplinary action for unsafe acts or practices.

3.2 PROJECT MANAGER

The Project Manager, Chad Tomlinson, has overall responsibility for the safe performance of project activities. If a health and safety issue arises in the course of performing the contract that requires consultation with the client, the Project Manager is responsible for contacting the appropriate client representative and obtaining agreement on necessary actions, and for providing project personnel with suitable guidance.

3.3 HSSE ADVISOR

The Stantec HSSE Advisor, Randy Jones, will provide corporate oversight of the Stantec Project from a Health and Safety standpoint. The Stantec Project Manager and Site Safety and Health Officer will coordinate with HSSE Advisor as required. The HSSE Advisor shall:

- Work with the SSHO to implement the requirements of this Health and Safety Plan.
- Be available for consultation with the Project Manager, Field Team Leade, and the SSHO during the course of field work covered by this Health and Safety Plan.
- If needed, conduct periodic inspections of field activities to evaluate the effectiveness of the health and safety program and compliance with the Health and Safety Plan.
- Assist in the preparation of and any subsequent amendment to the Health and Safety Plan.
- Consult with the Project Manager as necessary prior to approving changes to the Health and Safety Plan.
- Coordinate modifications to the Health and Safety Plan with the Project Manager and SSHO.

3.4 SITE SAFETY AND HEALTH OFFICER

The Stantec SSHO, which will be determined on a project to project basis, has the responsibility and authority to halt or modify any activity or to remove personnel from the site if he or she considers conditions to be unsafe. Their responsibilities include, but are not limited to:

- Serve as the project lead for all issues related to health and safety.
- Maintain necessary project health and safety documentation and records.
- Verify that employees wear the prescribed level of personal protective equipment.
- Be responsible for implementing the requirements of this Health and Safety Plan.
- Prepare incident reports for near miss accidents and actual work-related injuries, illnesses or losses involving the environment or property.
- Update and maintain a current Activity Hazard Analysis (Appendix A) that addresses potential hazards and associated controls.
- Maintain current certification in cardiopulmonary resuscitation (CPR) and first aid.
- Ensure that field personnel understand and comply with safety requirements, as outlined in this Health and Safety Plan.
- Ensure that a copy of the Health and Safety Plan accompanies each sampling team.
- Coordinate with the HSSE Advisor, Field Team Leader, and Project Manager to address any unanticipated conditions that develop during the course of field activities.
- Coordinate with any subcontractor-designated SSHO to resolve unsafe behavior and unsafe conditions posed by subcontractor personnel.
- Be responsible for dismissing subcontractor personnel when resolution of unsafe acts and conditions cannot be reached
- Obtain approval of amendments to the Health and Safety Plan from the Project Manager and HSSE Advisor before implementing any deviations from stipulated health and safety procedures.
- Provide the field personnel with the JRA worksheets and review them daily during tailgate safety meetings. Record the information on the Field Level Risk Assessment, RMS 2.
- Conduct and document daily safety debriefing meetings and inform team leader of any accidents or near hit/misses.
- Be responsible for controlling the entries to and exits from sampling locations.
- Monitor on-site hazards and conditions.
- Monitor field personnel for signs of thermal stress and fatigue.
- Enforce the buddy system.

- Enforce procedures for personnel and equipment decontamination, as specified in this Health and Safety Plan.
- Know emergency procedures and evacuation routes, as well as the telephone numbers of the nearest ambulance service, local hospital, poison control center, fire department, and police department.
- Verify the route to emergency medical facilities, and ensure that route information is posted.
- Serve as the primary Stantec contact during any on-site emergency.
- Direct responses to emergencies as outlined by emergency response plans (see Appendix E).
- Participate in accident/incident and near miss investigations.
- Ensure that personal protective equipment (PPE) specified for use in this Health and Safety Plan is available and is being used by project personnel.
- Ensure that equipment used for assessing health hazards is calibrated and maintained in good working order.
- Periodically inspect protective clothing, as well as equipment used for assessing health hazards, for defects and signs of wear.
- Inspect and maintain first-aid kits and other emergency supplies.
- Confirm with the HSSE Advisor or the responsible subcontractor official the ability of each individual assigned to field activities to perform site work and maintain a file of current training and medical surveillance certificates.
- Overseeing project-specific employee training and medical surveillance.
- Enforce written medical restrictions for field personnel, as necessary.

3.5 FIELD TEAM LEADER

The FTL, which will be determined on a project to project basis, is responsible for assembling and managing the field personnel and field equipment during the sampling event. He should thereby assist the SSHO in looking out for unsafe equipment and procedures. The FTL is also responsible for managing the sampling schedule and determining what team members sample what location or perform what task. There may be an occasional task or sampling location is more difficult to undertake, or reach, than others. It is therefore the responsibility of the FTL to delegate tasks responsibly, keeping safety in mind. The FTL is responsible for sending, via email, a daily field report to the P_4 Production Program Manager. Thus it is the responsibility of the FTL to discuss with the SSHO any incidents so that the FTL can include this in his/her daily report.

3.6 FIELD PERSONNEL

Field personnel are also responsible for understanding and complying with the requirements of this Health and Safety Plan and are required to sign an acknowledgment to that effect. Field personnel are also responsible for bringing perceived unsafe conditions, accidents, or near hits/misses to the attention of the FTL and SSHO during each daily safety debriefing meeting, or sooner if conditions warrant. During the daily tailgate safety meetings, any subcontractor personnel who will be providing services shall inform the rest of the field team of any additional hazards posed by their procedures or the operation of their equipment.

3.7 STANTEC SUBCONTRACTOR SAFETY PERSONNEL

Each Stantec Subcontractor shall designate a competent person (capable of recognizing hazards, with the authority to immediately correct) in a supervisory position, to administer its HASP. Should the Stantec Subcontractor's safety effort be considered inadequate, Stantec has the option to request replacement of the designated safety representative

3.8 SITE VISITORS

Visitors, including Stantec and subcontractor management or staff, regulatory agency personnel, or client personnel, may be present at the project site during field activities. Visitors can most likely be provided with a general viewing area at a safe location. The SSHO can provide a brief overview of the field activities to any site visitors.

If unannounced visitors request access to a project site, the SSHO shall inform the appropriate client representative to obtain permission or denial of access.

3.9 ACCIDENT INCIDENT INVESTIGATION AND REPORTS

All accidents and incidents, including near misses, involving Stantec and/or Stantec Subcontractor employees will be investigated. The Project Manager or designee will take the lead in conducting the investigation. If the Project Manager requires assistance, he/she will seek it from the HSSE Advisor. The investigation will be documented either using a Stantec incident report form (Appendix K, RMS3) or the Subcontractor's form. The original investigation report form will be forwarded electronically to hsse@stantec.com . (Refer to Appendix K for Stantec incident reporting protocol and forms.) A copy of the report shall be provided to the Stantec SSHO, and maintained in the project file on site

4.0 STANDARD OPERATING GUIDELINES

All site operations will be performed in accordance 29 CFR 1910 and 1926, and other applicable federal and state requirements and applicable Stantec HSSE Procedures (see Safe Work Practices in Section 7). All Stantec employees, Stantec Subcontractors, and visitors must comply with the requirements of this HASP.

4.1 RECORDKEEPING

The Project shall establish reporting and recordkeeping requirements in accordance with Federal and/or State law and Stantec HSSE RMS Procedures, Occupational Injury and Illness Reporting and recordkeeping, including reporting as required by P_4 and the Program Management Team. Examples of reports or records are:

- Incident Reporting – RMS 3 (Appendix K)
- Routine OSHA Reporting
- Safety and Health Records
- Field Level Risk Assessment – RMS 2 (Appendix H)
- Worksite Inspection: Field – RMS 5 (Appendix B)
- Management of Change Form – RMS 11 (Appendix B)
- Medical Surveillance Assessment – RMS9 (Appendix B)

4.2 GUIDELINES FOR OBSERVED OR IDENTIFIED HAZARDS

4.2.1 HAZARDS CREATED BY OR IDENTIFIED DURING WORK CONTROLLED BY STANTEC OR STANTEC SUBCONTRACTORS

When apparent non-compliance to the HASP or unsafe conditions or practices are observed, the Stantec Project Manager, and/or SSHO will be notified and corrective actions completed. For Stantec Subcontractor's, the subcontractor's SSHO or Project Manager will be notified and corrective actions will be required. For work activities performed by the subcontractor, the subcontractor is responsible for determining and implementing necessary controls and corrective actions.

When Stantec employees or Subcontractors may be exposed to an apparent imminent danger, immediately stop work and alert all affected individuals. Remove all affected Stantec and Stantec Subcontractor employees from the danger and notify the Project Manager, and/or SSHO, and the subcontractor's SSHO or Project Manager where appropriate. Do not allow work to resume until adequate corrective measures are implemented and documented and accepted by the SSHO or his/her designee.

4.2.1 HAZARDS IDENTIFIED WITH CLIENT OR OTHER THIRD-PARTY WORK ACTIVITIES

In carrying out Stantec's responsibilities of assuring safety compliance for Stantec and Stantec Subcontractor employees, the following guidelines are implemented when employees identify hazardous conditions created by the Client or Contractors (third party) within or adjacent to their work area:

If a condition is identified that could immediately result in an accident causing severe injury or death:

- Take appropriate measures to ensure your own safety and all other Stantec and Stantec Subcontractor employees by immediately removing yourself from the immediate danger of the hazard zone.
- Advise others in the area of your potential concern. This would include notifying the client representative. Do not advise how to correct the immediate hazard, only that one appears to exist.
- If the potential concern is not addressed, the Stantec employee should notify the Project Manager or his/her designee, who then may notify the Owner of the potential concern. It is the Owner's responsibility to determine, and implement if appropriate, the issuance of a stop work order or to suspend the affected activity. Additionally, only the Owner can authorize a restart of the suspended work activity following mitigation of the immediate hazard.

If a condition is identified that may not be an immediate danger, but could result in an accident involving less serious or minor injury, damage to equipment, or environmental release:

- Take appropriate measures to ensure your own safety and the safety of all other Stantec and/or Stantec Subcontractor employees in immediately removing yourself/them from the immediate hazard zone.
- Advise others in the area of your concern. This would include notifying the client representative. Do not advise how to correct the deficiency; only that it appears that one exist.

In either case, notify the Project Manager and/or SSHO. The situation will be evaluated and protective actions taken to ensure the safety of Stantec and Stantec Subcontractor employees during the performance of their work activities.

5.0 HEALTH AND SAFETY TRAINING REQUIREMENTS

Individuals assigned by STANTEC to complete field work in the Southeast Idaho Phosphate Resource Area will, as appropriate, be required to meet the general site worker standards of this Plan including the training requirements described below. It is important to start each meeting with a safety topic. This practice helps foster the incorporation of safety into all Stantec activities.

5.1 INITIAL SITE-SPECIFIC HEALTH AND SAFETY TRAINING

Site-specific health and safety training will be provided by P_4 to Stantec employees charged with completing the field assignments as part of this investigation. This site-specific safety training attempts to encompass all hazards that may be encountered at any of the P_4 mines. This training also contains a vehicle safety checklist that must be passed before driving on the premises is allowed. This training document is attached herein as Appendix G, *Monsanto Contractor/Guest ES&H Site Guidelines*. P_4 also requires contractors to complete a pre-Job Risk Analysis (JRA) worksheet for each individual job the contractor performs. JRAs are meant to bring to light the potential hazards and risks associated with each job. A blank JRA worksheet is attached herein as Appendix H. Furthermore, N.A. Degerstrom Inc., the contracted on-site mining operator, requires that all users of the haul roads at the site be trained in haul road safety. A copy of the Degerstrom training document is attached herein as Appendix I, *Degerstrom Ore Haul Road Travel Requirements*.

Based on available and extensive information, Stantec has demonstrated that the work being conducted under this plan does not involve the reasonable possibility for employee exposure to safety or health hazards attributable to hazardous substances. Furthermore, the waste rock, which is the source of contamination of interest, does not meet the four-prong definition of a hazardous substance per 29 CFR 1910.120(a)(3). Therefore, the training requirements of 40 CFR §1910.120 are not applicable to field personnel involved in the sampling efforts; however, it is recommended that all Stantec personnel are HAZWOPER trained.

It is the responsibility of the SSHO to review each area subject to sampling, prior to allowing a field team to enter the area, to ensure that none of the proposed sampling areas fall within the above-listed locations or activities. If a proposed sampling location or activity is determined by the SSHO (or other informed person) to fall within one of the above-listed locations or activities, the SSHO has the authority and responsibility to stop the proposed sampling activity until it is ascertained that the field personnel entering the area meet the requirements of 40 CFR §1910.120, including the appropriate level of HAZWOPER training.

Notwithstanding the above statements, Stantec expects that all field personnel are familiar with, understand, and follow the health and safety requirements and guidance provided in this manual. Training will be conducted prior to job start-up, and as needed thereafter. The HSSE ADVISOR, SSHO, and/or the Program Manager(s) will conduct the initial site-specific training to ensure that field personnel have a thorough understanding of this Health and Safety Plan, applicable standard operating procedures (SOPs), and the chemical, physical, and biological hazards that may be associated with the investigation. This training will be repeated for new field personnel tasked with field assignments connected with the investigation as well, prior to starting field work.

Topics that will be addressed in the initial site-specific health and safety training will include the following:

- Names of personnel and others responsible for project safety and health.
- Employee rights and responsibilities under OSHA.
- The Health and Safety Plan, including the medical surveillance program.
- The acute and chronic effects of exposure to hazardous substances that may be encountered during field activities; the potential routes of exposure and symptoms of exposure for these substances; the PELs and IDLH concentrations assigned to these substances; and the level of personal exposure that can be anticipated.
- Likely physical hazards such as slipping, tripping, or falling; noise; electrocution; being struck; or being caught in or between moving equipment.
- Site control measures, including procedures for chemical handling, spill containment, decontamination, fire prevention, and any SOPs prepared specifically for the project.
- Hazard communication (per the requirements of 40 CFR § 1910.1200).
- PPE and the action levels for upgrading PPE and for evacuating work sites.
- Engineered controls such as dust suppression techniques adopted for this project.
- Emergency procedures and equipment.
- Any procedures adopted for air monitoring, including the functions, limitations, use, and maintenance of monitoring equipment.

- Proper use of heavy equipment and machinery, as applicable.
- Personal cleanliness and restrictions on eating, drinking, and smoking at the job site.
- Heat and cold stress prevention, monitoring, and treatment.
- Contractor injury and illness prevention programs, if applicable.

Field Personnel will also be instructed in the use of the buddy system. The buddy system will be used whenever field personnel are collecting samples from any location in the project study area. The buddy system is a method of organizing work groups so that an individual is always available to provide his or her partner with assistance in an emergency; to monitor his or her partner for signs of chemical or physical exposure, to periodically check that his or her partner's PPE is functioning properly, and to notify emergency response personnel if an emergency occurs. The buddy system usually requires that two or more people maintain visual contact while working. However, the buddy system can employ radio or cell phone contact if site conditions are such that a person could otherwise work alone. In order to deviate from the buddy system, the HSSE ADVISOR will require an explanation of the specific task to be completed, along with a procedure for assuring that a single person work party is safe.

Note that activities that will be conducted during the investigation WILL require the MSHA 24-hour training specified under 30 CFR 48.21 through 48.30. The SSHO will maintain documentation that each site worker has successfully completed the initial site-specific training and any additional safety training furnished by a mine operator at an active mine site.

5.2 TAILGATE SAFETY MEETINGS

Tailgate safety meetings will be conducted by the SSHO each day field activities take place. This meeting will review the JRAs for the applicable jobs, cover site activities, changes in site conditions, other activity-specific health and safety issues, and include a review of pertinent topics detailed in the initial site-specific health and safety training. Field personnel will also be informed of the availability of emergency assistance, as well as the most probable route of evacuation from a site, should an evacuation become necessary.

A daily safety debriefing will also be conducted at the conclusion of every work day; at which any unsafe working conditions or equipment and any incidents or near hits/misses must be discussed and documented. The SSHO must inform the FTL of any such incidents.

If Stantec personnel are working directly with a contractor/subcontractor (i.e. a well driller, excavator), the Stantec contractor supervisor is to engage in this same tailgate safety meeting process and report to the SSHO or HSSE ADVISOR any safety concerns and incidents or near hits/misses.

5.3 BLOODBORNE PATHOGENS AND FIRST AID/CPR

Personnel assigned to conduct field work for this project do not conduct first aid or CPR as a primary job function. Rather, selected field personnel (e.g., the SSHO) have been trained in first aid and CPR for application in an emergency only. Acting in the capacity of a designated emergency first aid provider is not mandatory, and anyone who is uncomfortable with the possibility of being so designated should notify the SSHO.

5.4 DOCUMENTATION OF TRAINING

Written documentation verifying compliance with the training requirements of this section must be submitted to the Stantec HSSE ADVISOR or SSHO prior to the beginning of field work or site access. Documentation of each worker's current training credentials will be kept by the SSHO for review by authorized agency personnel.

6.0 REQUIRED MEETINGS

Stantec and Stantec Subcontractor employees are to attend a project safety orientation, as well as periodic safety meetings.

Stantec meeting safety topics discussed are to be documented accompanied with an attendance signature sheet. The Stantec meetings to be conducted are as follows:

Meeting Type	Purpose	Length	Frequency
Project Orientation	To acquaint employees with the Stantec Project scope of work and field activities.	Approximately one hour.	At time of first assignment to the Project.
Daily "Tailgate" Safety Briefs	To ensure that the methods of safely performing the work for the shift is understood by those performing the work. Discuss relevant AHA, weather, any special conditions. Documented as part of project work documentation	As needed, typically 15 to 30 minutes.	At the start of every work shift when field work is performed.
Monthly Safety Meeting or Pre-Task review of field work.	To cover specific safety topics; or to review hazards and safety practices required for field walk downs	Approximately 10-30 minutes.	Monthly or at the beginning of new field activities

The Field Level Risk Assessment – RMS 2 form (Appendix H) is included as a means of documenting these meetings.

7.0 MEDICAL SURVEILLANCE

Personnel who will be completing field assignments are required to complete a Medical Surveillance Form, RMS 9. This form must be completed upon field assignment and annually thereafter during the CDPR process. Activities governed by the requirements of 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response (HAZWOPER) must be dually noted on the RMS 9, Signed by the employee and submitted to the Supervisor and OSEC for enrollment in our medical surveillance program consistent with the requirements of that regulation. These requirements mandate that field personnel receive medical examinations prior to participating in hazardous waste site activities; annually; upon termination; following occupational exposure or injury; and additionally, as needed, on a case-by-case basis.

Our medical surveillance program is overseen by a licensed physician who is certified in occupational medicine by the American Board of Preventive Medicine, or, who by training and experience, is Board-eligible. When applicable, the SSHO will maintain copies of the physician's written authorization statements that employees conducting hazardous waste site operations are fit for hazardous waste site duty and are able to wear respiratory protection. No one shall be permitted to participate in hazardous waste site operations subject to these requirements until a copy of their medical certification is received by the SSHO. Copies of the physician's authorization for field personnel will be available to the field personnel upon request. Medical and exposure records will be retained for the length of the employee's employment, plus 30 years.

Field personnel will receive additional medical monitoring upon notifying the SSHO, HSSE ADVISOR, Program Manager, or other authorized Stantec personnel of symptoms consistent with over-exposure to site contaminants, or if the employee is injured or exposed to contaminants at concentrations at or exceeding a PEL during emergency response operations. Further medical examinations may be required before an employee returns to work after a serious illness or injury. Such examinations may be necessary to assure the employee's continued ability to carry out assigned duties. The need for these examinations will be determined by the Stantec HSSE ADVISOR, in cooperation with the occupational health physician representing the company. An injury or illness incurred by one of the field personnel, whether on or off the job, shall be reported to the SSHO immediately and an RMS 3 (HSSE Event Report) will be completed as outlined in Section 3.9 and Appendix K. Such injury or illness may also require work restrictions when/after the employee returns to work. If the injury or illness required seeing a physician, either the attending physician or the physician giving the employment physical will be involved in deciding when the employee can return to work, and if any work restrictions will apply.

8.0 PROJECT/SITE HAZARDS AND CONTROLS

8.1 SITE HAZARDS

This section of the HASP identifies activity-specific hazards that may be encountered at project sites during the course of planned field activities, as well as methods that will be employed to control exposure to these hazards. The field activities discussed herein include supervision of well drilling and development, supervision of test pit excavation, and collection of soil and groundwater samples. Activity locations will be at the Ballard Site or at potential borrow source locations southwest of the mine on P_4-owned property.

Some of the selected sample sites are readily accessible by vehicle; others, however, are not directly accessible by vehicle, and may require travel on foot. Health and safety issues that are associated with these sites requiring extensive foot travel will be addressed herein.

Specific activities that may be involved in the investigation are listed in Appendix A, Activity Hazard Analysis. Appendix A details the hazards that may be associated with these activities, and recommended controls to minimize risk to Stantec and subcontractor field personnel.

Although phosphate ore bodies are known to have slightly elevated concentrations of Uranium-238 (238U), radiation has not been identified as a worker hazard and monitoring for ionizing radiation will not be undertaken during the investigation. Additional safety practices more generally applicable to field activities are summarized in the subsequent sections of this plan.

This section of the HASP is meant to provide a brief description of the controls that should be taken to prevent injury to employees observing or participating in such tasks. The following categories of hazards are anticipated on the project:

- Biological and Wildlife Hazards
- Chemical Hazards
- Physical Hazards
- Environmental Hazards

A site-specific summary of key Safe Work Practices and other developed controls are highlighted in the following subsections. Relevant Safe Work Practices must be read and understood and are locally available and hyperlinked to this document as follows:

100 Series – General HSE

- ☐ 102 – Workplace Violence Prevention Program
- ☐ 103 – Workplace Hazardous Materials Information System (WHMIS)
- ☒ 104 - Hazard Communication
- ☒ 105 – Personal Protective Equipment (PPE)
- ☒ 107 – First Aid
- ☒ 108 – Bloodborne Pathogens
- ☒ 111 – Medical Surveillance
- ☒ 113 – Heat Stress
- ☒ 114 – Working in Cold Environments
- ☒ 115 – Material Handling and Safe Lifting
- ☐ 116 – Office Safety
- ☐ 118 – Working Alone in the Field
- ☒ 124 – Safe Driving
- ☐ 125 – Workstation Ergonomics
- ☐ 126 – Using a Chainsaw
- ☐ 130 – Rail Safety

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200 Series – Construction HSE

- ☐ 201 – Fall Protection/Working from Heights
- ☐ 202 – Ladder Safety
- ☐ 203 – Aerial Work Platforms
- ☐ 205 –Scaffold Safety
- ☒ 206 – Hand and Portable Power Tools
- ☐ 208 – Hoisting and Lifting

200 Series – Construction HSE

- ☒ 213 – Utility Clearance
- ☒ 214 – Entering Excavations and Trenches
- ☐ 215 – Supervision of Hydro-Excavation Activities
- ☒ 216 – Working Near Mobile Equipment
- ☐ 217 – Forklift Operation

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300 Series – Hazardous Materials

- ☐ 304 – Asbestos Safety
- ☐ 305 – Benzene Safety
- ☐ 308 – Working in Geotechnical and Materials Laboratories
- ☐ 310 – Compressed Gas Cylinders
- ☐ 311 – Working in Environmental Laboratories
- ☐ 312 – Fueling Gasoline Engines
- ☐ 314 - Working Around Hazardous Waste and Wastewater
- ☒ 315 - Arsenic Safety

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400 Series – Program Specific

- ☐ 406 – Electrical Safety Program
- ☐ 407 - Traffic Control and Protection Planning
- ☐ 408 – Lock, Tag & Try (LTT)
- ☐ 409 – Respiratory Protection
- ☐ 411 – Confined Space Entry
- ☐ 414 – Hot Work
- ☒ 416 – Supervision of Contracted Drilling Activities

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500 – PA/PC/Regn Sp Programs

☐ 501 - Using the Spot Messenger System

☐ 502 - Use and Handling of Nuclear Density Gauges

☐ 504 - Backpack and Boat Mounted Electro-fishing

☐ 507 – Aircraft Safety

☒ 508 – Wildlife Encounters

☐ 509 - Guideline for 2-way Radio Use on Radio Controlled Roads in BC

☐ 510 – Working in Abandoned Buildings

☐ 513 – Boat and Water Safety

☐ 514 – Working On or Near Ice

☐ 516 – Radiation Safety (US)

☐ 517 – Safe Machete Use

☐ 519 – Post-Disaster Building Entry

8.2 FIELD/SITE VISITS

A Field Level Risk Assessment, RMS 2 (Appendix H) will be completed each day prior to field work to address the tasks to be accomplished, update current site conditions, address hazards, acknowledge fitness for duty and document the activities. Staff shall wear the proper personal protective equipment (PPE) while performing their tasks. Safety vests are required for all field activities where staff is exposed to equipment operation or vehicle traffic.

8.2.1 FIELD SITE ACCESS

Any staff member entering a project area managed by the Client or Client's Contractor will comply with their health and safety requirements. Staff will inquire as to the work activities being performed, potential hazards, policies and site requirements and the protocol for site visitors entering the site.

A site briefing may be provided by the Client or Contractor prior to entering the site.

8.3 BIOLOGICAL AND WILDLIFE HAZARDS

Biological hazards that could potentially be encountered at during the pre-design work may include snakes, spiders, ticks, fleas, big game and other wildlife, aggressive livestock, poisonous/irritating plants such as poison oak and poison ivy, and micro–organisms such as the hantavirus.

Field personnel should be aware of their surroundings and avoid contact with snakes and insects. Snakes, spiders, and fleas typically occupy cool, dark, moist areas. The possibility of an encounter most frequently arises when reaching into dark, covered places. Suggestions for controlling the risks associated with snakes and insects include using a long stick to break apart webs or to remove soil cover from sheltered areas. A flashlight should also be used to inspect dark cavities before reaching into them.

Big game animals (deer, elk, and moose) are often seen from vehicles while traveling to and from sites but are easily scared away and are rarely seen on foot. If big game is encountered while on foot, the National Parks Service (NPS) recommends staying at least 75 ft (25 yds) away. While generally docile, if game feel threatened, they will charge and attack; especially females with young. Other more dangerous wildlife (but notably more uncommon) may include wolves, bear, mountain lions, and coyotes. The NPS recommends staying at least 300 ft (100 yds) away if one of these is encountered.

Aggressive livestock are another (rare but legitimate) biological safety concern. It may be necessary to enter an active pasture to access a sample location. Livestock are generally very skittish and can easily be frightened, but personnel should still be cautious, maintain a distance of 75ft (25 yds), and avoid turning their back on the animals. A pasture or enclosure with a male cow (bull) should never be entered. Adult males are generally separated from the females and juveniles and are kept by themselves. They are easily distinguished and are very volatile; they should not be approached.

As a matter of courtesy, field personnel should obtain permission from private landowners prior to entering private lands and immediately close any gates opened in order to access sampling stations and when leaving such stations to make sure that livestock do not inadvertently escape.

Poisonous plants such as poison ivy and poison oak grow wild in dark, moist areas, and at the base of or around seedling and adult trees. Some individuals are prone to skin rashes on contact with the oil from certain plants. A visual site inspection and identification of possible poisonous plants should be completed prior to each shift so that assigned personnel are aware of the potential for exposures.

The Center for Disease Control in Atlanta, Georgia has established a hotline for inquiries regarding the hantavirus, at (877)-232-3322. Hantavirus has resulted in several deaths in the western part of the United States. While there may not have been any outbreaks or notices of the virus at a given project site, field personnel should be aware of the exposure route for the hantavirus and potential control methods. The hantavirus is transmitted through atmospheric dispersion of dried rodent excreta. The disease associated with the hantavirus begins with one or more symptoms that may include fever, muscle aches, headache, and cough. The disease progresses rapidly to a severe lung disease that often requires intensive care and treatment.

The following biological hazards are discussed in detail below:

- Microbial (mold, bacteria, viral, etc.)
- Hazardous Plants
- Poisonous Snakes
- Ticks
- Bees and Yellow Jackets
- Mosquitoes (West Nile, Malaria, Japanese Encephalitis)
- Spiders
- Scorpions
- Animal Bites/Animal Borne Diseases
- Bird and Rodent Droppings
- Bears
- Mountain Lions

The subsections below briefly describe each of the above hazards and the control measures for each.

8.3.1 MICROBIAL

Microbial related project risks are generally associated with exposure to untreated water and soils. If these media are contaminated with animal fecal matter or animal remains, they can present a risk of infection to unprotected workers and/or where personal hygiene is difficult.

Escherichia coli O157 is a species of bacteria. The most common type of E. coli infection that causes illness in people is called E. coli O157. Symptoms of E. coli O157 include watery or bloody diarrhea, fever, abdominal cramps, nausea, and vomiting. Illness may be mild or severe. In addition to the more common route of ingesting contaminated food, infection from E. coli can occur for exposure it contaminated water, either through open wounds or ineffective hygiene methods when working with or in E. coli-contaminated water.

Cryptosporidium infection (cryptosporidiosis) (krip-toe-spo-rid-ee-oh-sis) is a parasitic disease caused by Cryptosporidium parvum. It usually causes a mild to severe infection of the gastrointestinal system, including watery diarrhea, fever, abdominal cramps, nausea, and vomiting.

Giardia is a microscopic parasite that causes the diarrheal illness known as giardiasis. Giardia (also known as Giardia intestinalis, Giardia lamblia, or Giardia duodenalis) is found on surfaces or in soil, food, or water that has been contaminated with feces from infected humans or animals. Giardia is protected by an outer shell that allows it to survive outside the body for long periods of time and makes it tolerant to chlorine disinfection. While the parasite can be spread in different ways, water is the most common method of transmission.

Leptospirosis is also known as Weils Disease and is bacterial infection that can be caused by exposure to wastewater. The bacteria enter through skin cuts or abrasions, or through the lining of the mouth, throat or eyes. The infection causes flu-like illness with a persistent and severe headache which can lead to vomiting and muscle pain and ultimately it can lead to jaundice, meningitis and kidney failure. In rare cases this disease can be fatal.

Methicillin-resistant Staphylococcus Aureus (MRSA) is a type of staph bacteria that is resistant to certain antibiotics called beta-lactams. Outside healthcare, most MRSA infections are skin infections.

8.3.2 HAZARDOUS PLANTS

Several types of allergenic plants may be encountered onsite, including poison oak, poison ivy, poison sumac, and stinging nettles. These plants exude oils which cause an allergic reaction when in contact with skin. The oil will linger on hand tools, cloths, or other surfaces for several days and can be transferred onto exposed skin from any of these items. All field equipment and clothing (including shoes) should be washed each day if contact with these plants is possible, even if these plants are not specifically observed during work activities.

The best method for preventing an allergic reaction is to avoid contact with poisonous plants. Plant descriptions and photographs to aid in the identification and avoidance of poison oak are shown below.

Poison Oak	Poison Ivy
	

Poison Sumac	Stinging Nettle
	

Poison Oak is a leafy shrub which can grow to a height of about six feet when free-standing, but it can also grow as a vine which intertwines with tree limbs or other plants. Poison oak can thus be overhead as well as on the ground. The leaves can vary in color from copper-colored (typically in early spring) to bright green, and typically appear in groups of three leaflets as pictured above. The plant produces small flowers in spring which can be white, yellow, or green. During summer months, the plant produces small berries colored white or light yellow. Poison oak releases an allergenic oil when the leaves are damaged, and the oil binds to skin within minutes of contact.

Poison Ivy is also a leafy shrub or vine exhibiting three-leaf clusters. Leaves are typically pointed, as pictured above, and generally appear glossy even when dry. Leaves may vary from bright red to copper-colored in the spring/fall, and are typically green in the summer. The plant may flower with green to yellow blossoms, and may produce green or white berries. Poison ivy sap contains an allergenic oil. This oil may be present directly on the leaves or stems without damaging the plant, so brushing against the plant may be enough to cause an allergic reaction.

Poison Sumac is leafy shrub or small tree which commonly grows in wet and heavily wooded areas. It is much less common in Colorado than the other poisonous plants described herein, but may still be present at the project site. Poison sumac grows with long fern-like stems which often contain 10 or more leaves per stem. Leaves are long and pointed, and contact with these leaves is sufficient to transfer allergenic oil onto exposed skin, clothing, tools, etc. Leaves are typically green, and plants may produce clusters of white or green/yellow berries.

Stinging Nettles are found in wet areas such as beside streams and ponds, and typically grow as tall and slender plants with a central vertical stem and with leaves expanding off of it. Leaves are long and pointed with noticeably jagged edges. The plant may produce groups of small white or purple flowers. Stems and/or leaves have small hairs which contain allergenic oils.

If exposed to these poisonous plants, act quickly, because the toxin in the plant penetrates the skin within minutes. If possible, stay outdoors until you complete the first two of the five following steps:

1. Cleanse the exposed skin with generous amounts of isopropyl alcohol.
2. Wash the skin with water. Do not use soap at first because it will pick up the toxin from the surface and spread it around.

3. Take a regular shower with soap and warm water.
4. Wash clothes, tools, and anything else that may have been in contact with the toxin, with alcohol and water. Be sure to wear hand protection during this process.
5. See a medical professional if needed.

Signs and symptoms of exposure to poison oak, poison ivy, or poison sumac include redness and swelling that appears 12 to 48 hours after exposure. Blistering and itching will follow. Severe reactions may include puss emanating from blisters and could lead to difficulty breathing. If you have a severe reaction (or have had a severe reaction in the past), you should see an occupational physician right away. Otherwise, according to the Federal Drug Administration, there are quite a few effective over-the-counter products to help with symptoms, including Cortaid and Lanacort, baking soda, Aveeno oatmeal bath, and calamine lotion. An occupational care consultant, or a pharmacist, can help you make an educated choice.

Signs and symptoms of exposure to stinging nettles include swelling and bumps on affected areas of the skin, similar in size and shape to a mosquito bite. Bumps will be painful at first, and will become less painful over time. Swelling of affected areas could result during severe reactions, and you should see an occupational physician right away. Field treatment should include washing affected areas with water and/or isopropyl alcohol. Topical products mentioned above may also help to relieve pain in affected areas. An occupational care consultant, or a pharmacist, can help you make an educated choice

Poison Oak could be found on site and surrounding areas and may cause an allergic reaction. In the U.S., poison ivy (Rhus radicans) grows everywhere but on the West Coast, while another vine (sometimes shrub), poison oak (Rhus diversilobum) grows primarily on the West Coast, below an elevation of about 5,000 feet.

Poison Oak is extremely variable in growth habit and leaf appearance. It grows as a dense shrub in open sunlight, a tree with an 8–20 cm (3.1–7.9 in) trunk under conditions with ample sunlight, very wet winter/spring and dry summer, or as a climbing vine in shaded areas. Like poison-ivy, it reproduces by creeping rootstocks or by seeds.[1] The leaves are divided into three (rarely 5, 7, or 9) leaflets, 3.5 to 10 centimeters (1.4 to 3.9 in) long, with scalloped, toothed, or lobed edges — generally resembling the leaves of a true oak, though the western poison oak leaves will tend to be more glossy. Leaves are typically bronze when first unfolding, bright green in the spring, yellow-green to reddish in the summer, and bright red or pink in the fall. White flowers form in the spring and, if fertilized, develop into greenish-white or tan berries. Poison oak is winter deciduous, so that after cold weather sets in, the stems are leafless and bear only the occasional cluster of berries. Without leaves, poison oak stems may sometimes be identified by occasional black marks where its milky sap may have oozed and dried.

Photographs to aid in the identification of poison oak are shown below.

Poison Oak

Poison Oak	Poison Ivy
	

The following four characteristics are sufficient to identify poison ivy in most situations: (a) clusters of three leaflets, (b) alternate leaf arrangement, (c) lack of thorns, and (d) each group of three leaflets grows on its own stem, which connects to the main vine.

The appearance of poison ivy can vary greatly between environments, and even within a single area. Identification by experienced people is often made difficult by leaf damage, the plant's leafless condition during winter, and unusual growth forms due to environmental or genetic factors.

If exposed to poison oak or ivy, act quickly, because the toxin in the plant penetrates the skin within minutes. If possible, stay outdoors until you complete the first two of the five following steps:

1. Cleanse the exposed skin with generous amounts of isopropyl alcohol.
2. Wash the skin with water. Do not use soap at first because it will pick up the toxin from the surface and move it around.
3. Take a regular shower with soap and warm water.
4. Wash clothes, tools, and anything else that may have been in contact with the toxin, with alcohol and water. Be sure to wear hand protection during that process.
5. See a medical professional if needed.

Signs and symptoms of exposure include redness and swelling that appears 12 to 48 hours after exposure. Blistering and itching will follow. If you have had a severe reaction in the past, you should see an occupational physician right away. Otherwise, according to the Federal Drug Administration, there are quite a few effective over-the-counter products to help with symptoms, including Cortaid and Lanacort, baking soda, Aveeno oatmeal bath, and calamine lotion. An occupational care consultant, or a pharmacist, can help you make an educated choice.

8.3.3 SNAKES

There are venomous snake species found in the area. Species include the Prairie Rattle, Massasauga and Western Diamondback Rattlesnake. Rattlesnakes are often found under rock outcrops and shaded areas. They are most active at temperatures between about 70 and 90 degrees Fahrenheit and are most active in the spring and fall, during morning or evening.

Precautions to lower the risk of being bitten include:

- Leave snakes alone, many people are bitten because they try to kill a snake or get a closer look.
- In areas known to have snakes present wear snake chaps to protect the lower legs from snake bites.

- Stay out of tall grass unless you wear tall thick leather boots and remain on paths as much as possible.
- Keep hands and feet out of areas that you can't see.
- If you encounter a snake, walk around it, giving it a berth of approximately 6 feet.
- If you are bit by a snake, immediately seek medical help, whether the snake is believed to be venomous or not.

For a venomous snakebite victim, the following first aid should be administered:

- Wash the bite with soap and water.
- Immobilize the bitten area and keep it lower than the heart.
- Immediately seek medical help.
- Do not ice or cool the bite; do not apply a tourniquet; do not cut into the wound!

8.3.4 TICKS

Lyme disease is an illness caused by bacteria which is transmitted to animals and man through the bite of infected ticks. Ticks that are carriers in the different regions include:

- The deer tick (Ixodes dammini).
- The black-legged tick (Ixodes scapularis).
- The western black-legged tick (Ixodes pacificus).
- The lone star tick (amblyomma americanum).
- The American dog tick (dermacentor variabilis).

Not all ticks are infected. Infection rates in tick populations vary by tick species and geographic region from as few as two percent to 90 percent or more.

The deer tick is responsible for most of the cases of Lyme disease in the United States. These ticks are found in grassy areas (including lawns), and in brushy, shrubby and woodland sites, even on warm winter days. They prefer areas where some moisture is present. The tick has three life stages: larva, nymph and adult. Each stage takes a single blood meal. They feed on a variety of warm blooded animals including man, dogs, cats, horses and cows. The bite is painless so most victims do not know they have been bitten. The nymph stage appears to be responsible for most Lyme disease cases. Both the larval stage (about the size of a grain of sand) and nymph stage (about the size of a poppy seed) attach to a variety of small mammals, but prefer the white-footed mouse, the main reservoir of the Lyme disease bacteria. The adult ticks (about the size of a sesame seed) prefer to feed on white-tailed deer. The entire life cycle requires three separate hosts and takes about two years to complete.

Larval and nymph deer ticks also attach to birds. Indeed, birds may be a primary means by which the ticks (some infected) are spread from one area to another. Some species of birds also function as a reservoir of infection.

Lyme Disease Symptoms and Treatment

In about 50% of the cases a characteristic rash or lesion is seen. It begins a few days to a few weeks after the bite of an infected tick. The rash generally looks like an expanding red ring. It is often described as looking like a bull's-eye with alternating light and dark rings. However, it can vary from a reddish blotchy appearance to red throughout, and can be confused with poison ivy, spider or insect bite, or ringworm. At about the same time that the rash develops, flu-like symptoms may appear with headache, sore throat, stiff neck, fever, muscle aches, fatigue and general malaise. Some people develop the flu-like illness without getting a rash.

Seek prompt medical attention if any of these symptoms appear, especially after being bitten by a tick or visiting an area where Lyme disease is common. If possible document the presence of the rash by taking a picture because it may disappear before a physician can see it.

If ignored, the early symptoms may disappear, but more serious problems can develop months to years later. The later symptoms of Lyme disease can be quite severe and chronic. Muscle pain and arthritis, usually of the large joints is common. Neurological symptoms include meningitis, numbness, tingling, and burning sensations in the extremities, Bell's palsy (loss of control of one or both sides of the face), severe pain and fatigue (often extreme and incapacitating) and depression. Heart, eye, respiratory and gastrointestinal problems can develop. Symptoms are often intermittent lasting from a few days to several months and sometimes years. Chronic Lyme disease, because of its diverse symptoms, mimics many other diseases and can be difficult to diagnose.

Lyme disease is treated with antibiotics. Timely treatment increases chances of recovery and may lessen the severity of any later symptoms in both animals and man. The most effective treatment will be recommended by your physician. Treatment for later stages is more difficult often requiring extended and repeated courses of antibiotic therapy and treatment failures and relapses are reported.

Preventing Tick Bites

- When out of doors several precautions can minimize your chances of being bitten.
- Tuck your pant legs into your socks and your shirt into your pants.
- Wear light colored clothing. Dark ticks are more easily spotted against a light background.
- Inspect clothes often for ticks. Have a companion inspect your back and other hard to see areas.
- Apply repellents according to label instructions. Applying directly to clothing appears to be most effective.
- Upon returning to the home remove clothing and wash or put it in the dryer for 30 minutes to kill any ticks.
- When you get in from the field; shower and inspect your body thoroughly. Especially check groin, navel, armpits, head and behind knees and ears. Have a companion check your back, or use a mirror.
- When hiking, stay in the middle of trails.

How to Remove Attached Ticks

Prompt removal of ticks decreases the chances of getting Lyme disease. The proper and easiest method is to grasp the tick with fine tweezers, as near the skin as you can, and gently pull it straight out. Be careful not to squeeze the tick when removing it which could result in more bacteria being injected. After removing the tick, quickly fill the hole in the skin with triple antibiotic cream. Do not try to remove the tick with your fingers or attempt to remove with lighted cigarettes, matches, nail polish, or Vaseline.

Once removed save the tick for identification. Accurate identification becomes very important if you or your animals develop disease symptoms. Proof of tick bite and the kind of tick doing the biting is especially important to document in areas where Lyme disease is not considered prevalent and doctor suspicion is low.

In most areas, ticks can be submitted for identification through local or state health department offices. Many physicians and veterinarians will also submit ticks. Put the tick in a tightly closed container with a small amount of alcohol (rubbing alcohol will do). Mark it with your name, address and phone number, date collected, host collected from (animal or man) and recent travel history.

8.3.5 BEES AND YELLOW JACKETS

Most encounters with bees and yellow jackets occur when nests in low human traffic areas are disturbed. Before entering an area or opening an enclosure that is not frequently disturbed, take a few moments to observe whether or not insects are entering or exiting. If they are flying to or from the area or enclosure, avoid it if possible. If you must be in an area where disturbing a nest is likely, be sure to wear long pants and a long-sleeved shirt. Yellow and light green clothing and reflective vests with accents of these colors are prohibited at the Site due to the possibility of attracting yellow jackets. Stinging insects fly around the top of their target, so if you get into trouble, cover your head if possible and run away.

If you get stung, look for a stinger, and, if present, remove. Several over-the-counter products or a simple cold compress can be used to alleviate the pain of the sting. If the sting is followed by severe symptoms, or if it occurs in the neck or the mouth, seek medical attention immediately because swelling could cause suffocation.

If you need to destroy a nest, consult with the H&S Representative first. Commercially available stinging insect control aerosols are very effective, but could potentially contaminate the area.

Once the nest is destroyed, fine mesh may be applied over the exit and entry points of an enclosure to prevent re-infestation.

Employees with a known bee sting allergy should carry an EpiPen® prescribed by their personnel physician. These employees shall let the SSHO about this allergy and where the EpiPen® will be kept while that employee is on-Site.

8.3.6 MOSQUITOES

Mosquitoes in the U.S. have been known to carry West Nile Virus, St. Louis encephalitis, and Dengue Fever. To avoid mosquito bites:

- Apply insect repellent containing N,N-Diethyl-meta-toluamide (DEET) when you're outdoors.
- Read and follow the product directions whenever you use insect repellent.
- Wearing long-sleeved clothes and long pants treated with repellent to further reduce your risk, as will staying indoors during peak mosquito feeding hours (dusk until dawn).
- Limit the number of places available for mosquitoes to lay their eggs by eliminating standing water sources from around the work area.

8.3.7 SPIDERS

The most dangerous spiders to humans in North America are Black Widows and Brown spiders (also known as Brown Recluse or Fiddleback spiders). Although Black Widows and Brown spiders are relatively rare at the site and surrounding locations, there are indications that these spiders may be transported fairly easily. With the transfer of large amounts of construction materials, transfer to the site of these spiders is possible.

A guide to identifying these spiders is presented below.

Black Widow Spider Identification Abdomen usually shows hourglass marking; the female is 3-4 centimeters in diameter; have been found in well casings and flush-mount well covers; not aggressive, but more likely to bite if guarding eggs; symptoms include light, local swelling and reddening of the bite are early signs of a bite, followed by intense muscular pain, rigidity of the abdomen and legs, difficulty breathing, and nausea; and if bitten, immediately seek medical help.	

Brown Spiders (Recluse) Identification Has a ¼- to ½-inch-long body, full grown are approximately the size of a silver dollar, legs included. Prefers to hide in baseboards, ceiling cracks, and undisturbed piles of material. At first the bite may either go unnoticed or be followed by a severe localized reaction, including scabbing, necrosis of affected tissue, and very slow healing. If bitten, immediately seek medical help.	

8.3.8 SCORPIONS

The scorpions in the US range through the Southern and Southwestern United States. Scorpions usually hide during the day and are active at night. They may be hiding under rocks, wood, or anything else lying on the ground. Some species may also burrow into the ground. Most scorpions live in dry, desert areas. However, some species can be found in grasslands, forests, and inside caves.

Symptoms

Symptoms of a scorpion sting may include:

- A stinging or burning sensation at the injection site (very little swelling or inflammation)
- Positive "tap test" (i.e., extreme pain when the sting site is tapped with a finger)

- Restlessness
- Convulsions
- Roving eyes
- Staggering gait
- Thick tongue sensation
- Slurred speech
- Drooling
- Muscle twitches
- Abdominal pain and cramps
- Respiratory depression

These symptoms usually subside within 48 hours, although stings from a bark scorpion can be life-threatening.

Preventing Scorpion Stings

Workers should take the following steps to prevent scorpion stings:

- Wear long sleeves and pants.
- Wear leather gloves.
- Shake out clothing or shoes before putting them on.
- Workers with a history of severe allergic reactions to insect bites or stings should consider carrying an epinephrine auto injector (EpiPen®) and should wear a medical identification bracelet or necklace stating their allergy.

First Aid

Workers should take the following steps if they are stung by a scorpion:

- Contact a qualified health care provider or poison control center for advice and medical instructions.
- Ice may be applied directly to the sting site (never submerge the affected limb in ice water).
- Remain relaxed and calm.
- Do not take any sedatives.
- Capture the scorpion for identification if it is possible to do so safely.

8.3.9 ANIMAL BITES/ANIMAL BORNE DISEASE (OTHER THAN DROPPINGS)

In addition to the potential physical injury, bites and contact with animals can present significant health issues. Infection can result from the penetrating wound of bite and diseases from animals can be transmitted to humans by vectors hosted by an animal (ticks, fleas

Rabies

Rabies is a disease caused by the rabies virus. It may take several weeks or even a few years for people to show symptoms after getting infected with rabies, but usually people start to show signs of the disease 1 to 3 months after the virus infects them. The early signs of rabies can be fever or headache, but this can change quickly to nervous system signs, such as confusion, sleepiness, or agitation. Once someone with rabies infection starts having these symptoms, that person usually does not survive. This is why it is very important to talk to your doctor or health care provider right away if any animal bites you, especially a wild animal.

Many kinds of animal can pass rabies to people. Wild animals are much more likely to carry rabies, especially raccoons, skunks, bats, foxes, and coyotes. However, dogs, cats, cattle (cows), or any warm-blooded animal can pass rabies to people. People usually get rabies from the bite of an infected animal. Many animals, such as dogs, cats, and horses are vaccinated against rabies, but you should always wash any bite thoroughly and check with your health care provider about what to do if any animal bites you.

Plague

Plague is a rare bacterial disease caused by Yersinia pestis (yer-SIN-ee-ah PEST-iss). People usually show symptoms 2 to 6 days after getting plague. Symptoms include fever, chills, weakness, and swollen and painful lymph nodes. A few people get pneumonia (infection of the lungs) as a first symptom of plague. The infection then spreads to other parts of the body. If this disease is not treated right away, many people who get sick will not survive.

People can get plague from an infected animal, but this is very rare. Rodents (for example, mice, rats, and squirrels) and cats are animals that can carry plague. This disease most often occurs in the southwestern part of the United States. Usually, people get plague from the bite of an infected flea. Since fleas bite both people and animals, especially cats and rodents, an infected flea can pass plague to animals or people. Sometimes, people get plague from working with an animal that is infected. People also can get infected by breathing in tiny droplets of water contaminated with Y. pestis.

Tularemia

Tularemia is caused by the bacteria Francisella tularensis and is characterized by sudden onset of high fever and chills, joint and muscle pain, and prostration. Slow-healing sores or lesions develop at the site of entry of the bacteria (or arthropod bite). Inflammation and swelling of nearby lymph nodes follow.

The bacteria is maintained in rabbits, hares, rodents, and birds by tick transmission. The natural reservoir for the bacteria includes infected ticks and animal species that are less susceptible and thus survive acute infections. Hard ticks, primarily D. andersoni, D. variabilis, and Haemaphysalis leporispalustris, and some flies, especially the deerfly (Chrysops discalis), can subsequently transmit the disease to humans. Tularemia can also be transmitted directly to humans. Transmission routes include drinking contaminated water; eating contaminated food or improperly cooked game meat; inhaling aerosols contaminated with rodent urine, feces, or dust; cuts from contaminated knives or other instruments; and scratches or bites from infected animals.

8.3.10 BIRDS AND RODENT DROPPINGS

Bird Droppings

Large populations of roosting birds may present a disease risk. The most serious health risks arise from disease organisms that grow in the accumulations of bird droppings, feathers, and debris under a roost, especially if roosts have been active for years. Among the fungal diseases associated with bird droppings, the two most common are Histoplasmosis and Cryptococcosis.

If you are working in an area where large quantities of droppings are present, follow certain precautions to minimize the risk from disease organisms in the droppings:

- Wear a respirator that can filter particles as small as 0.3 microns, such as a HEPA filter.
- Wear disposable protective gloves, hat, coveralls, and boots if you will be in close contact.
- Wash at the work Site after cleanup, if possible.
- Modify the structure or use methods to prevent birds from reestablishing the roost.

Rodent Droppings

In the United States, deer mice are the predominant carrier of Hantavirus which causes Hantavirus pulmonary syndrome (HPS) in humans. This virus occurs in rodent urine, feces, or saliva, and is transported via aerosol particles, which can cause the fatal respiratory disease when inhaled.

The deer mouse has big eyes and big ears and its head and body are normally about 2 - 3 inches long, and the tail adds another 2 - 3 inches in length. It has been observed in a variety of colors, from gray to reddish brown, depending on its age. The underbelly is always white and the tail has sharply defined white sides. All Site workers must eliminate or minimize contact with these rodents and any areas of obvious rodent infestation.

Hantavius Pulmonary Syndrome Symptoms and Treatment

There is no specific treatment, cure, or vaccine for Hantavirus Pulmonary Syndrome (HPS) infection. However, it is known that if infected individuals are recognized early and receive medical care in an intensive care unit, they may do better. In intensive care, patients are intubated and given oxygen therapy to help them through the period of severe respiratory distress. HPS will manifest symptoms in 1 to 5 weeks after exposure to mice or rats that carried a Hantavirus. Initially symptoms of HPS will be:

- Fever
- Severe muscle aches in the large muscle groups-thighs, hips, back, and sometimes shoulders. These symptoms are universal.
- Fatigue
- After a few days difficulty in breathing occurs. Symptoms can also include headaches, dizziness, chills, nausea, vomiting, diarrhea, and stomach pain.

Preventing HPS

It is important to avoid actions such as sweeping that raise dust in closed structures, since the infection occurs when the virus particles are inhaled. All structures on-Site will be aired out and decontaminated during start-up operations in the spring in an effort to prevent transmission of the virus. An effective decontamination agent is a dilute solution of bleach, consisting of 1 part commercial liquid bleach to 9 parts water.

8.3.11 BEARS

Black bears have been observed at the site and surrounding area. They are most active during early and late hours in the day and are more frequently seen along streams.

Food waste and similar trash must be contained in animal/bear proof refuse containers. Bears are attracted by food odors therefore all food and garbage items must be well wrapped. All garbage must be disposed of properly.

Vehicles are not to be left as bears have been known to break into vehicles. Exceptions can be made for industrial types of vehicles (water trucks, drill or development rigs, heavy equipment, etc.) if all trash, food (including crumbs), and drink have been cleaned from the cab and the vehicle has been inspected by the Stantec Project Manager or designee. After receiving approval from the Stantec Project Manager or designee, the vehicles windows must be closed and the doors left unlocked.

Most bear encounters end peacefully with the animal leaving the area. If a bear is encountered:

- Don't run away or run past the bear.
- Carry and use an air horn to make loud noise or yell loudly and slowly reach for the can of bear spray.
- If you are in a group, gather together and yell loudly.
- If you are alone, remain calm. If you are wearing a jacket, raise it above your head to make yourself appear larger or wave your arms above your head. Speak calmly and firmly. Do not make threatening gestures. Try to stay still until the bear leaves, or back away slowly until the bear is out of sight. Don't turn and run.
- DO NOT PLAY DEAD. Black bears are scavengers and, unlike grizzly bears, will not leave something alone that appears to be dead.
- DO NOT CLIMB A TREE. Black bears are good climbers and by attempting to climb a tree you can effectively trap yourself.
- DO NOT get between a bear and its cubs.
- If a bear appears to charge you, stand your ground. Many times, the bear will make a bluff charge prior to actually attacking. This charge is designed to make you back down before the bear has to actually attack. If a bear bluff charges you begin to back away slowly so that the bear can see you backing off.

If a bear attacks someone, take the following steps:

- If a bear charges, stand your ground. Attempt to jump quickly to the side (far enough to be out of the bears reach) shortly before the bear reaches you. Bears are capable of reaching charging speeds of approximately 30 miles per hour but cannot stop or change directions quickly.
- If you are being attacked, fight back and attempt to strike the bear in the nose, it is one of the most sensitive parts of the bear's body.
- If the bear is still within view after the attack, tend to the victim, then look for features on the bear that can be used to identify it such as an ear tag, scars, different colors areas of the body so that the bear can be identified at a later date.
- Check on the victim's condition and if the injuries are life threatening, call for professional medical care.

8.3.12 MOUNTAIN LIONS

Mountain lions have been observed near the site. Other species including Bobcats and the Canadian Lynx have not been observed at or near the Site, but may be encountered. To avoid encounters with Mountain Lions or other similar predators at the Site, observe the following procedures:

- Avoid working by yourself in an isolated area at either dawn or dusk as cats are most active at this time.
- Do not approach a mountain lion.
- If you are in a group, gather together.
- If you are alone, remain calm. If you are wearing a jacket, raise it above your head to make yourself appear larger or find anything to hold or rise above yourself to make yourself look as big as possible. Speak calmly and firmly, or attempt to yell for help, while remaining calm. Do not make threatening gestures. Try to stay still until the cat leaves, or back away slowly until the cat is out of sight. Don't turn and run.
- DO NOT CLIMB A TREE. Mountain Lions are good climbers and by attempting to climb a tree you can effectively trap yourself; and
- DO NOT RUN. If you run, a mountain lion may identify you as prey and it may actually encourage an attack.

If a cat attacks someone, take the following steps:

- If you are being attacked, fight back; use anything you can, such as rocks, tree branches, tools. Try to remain standing.
- Render first aid and call for professional medical care.

8.4 CHEMICAL HAZARDS

The primary chemicals of concern (COCs) identified for this project are:

- Natural chemicals associated with the Phosphate Mine, Table 8-1
- Field calibration standards and buffer solutions
- Nitric Acid
- Chemical reagents for field analyses
- Phosphate free detergent
- Hydrocarbon fuels: Gasoline and Diesel
- Lubricants and Greases
- Coolants and Anti-freeze
- Solvents

A Hazard Communication Plan is included in Appendix B (SWP 104). A copy of this will be available to field personnel. As necessary, the hazard communication program of subcontractors also will be solicited for use as a project reference. Stantec and subcontractor field personnel will be made aware of the Stantec Hazard Communication Program and have access to SDSs for any chemicals brought to field sites. Stantec will be responsible for supplying SDSs and each field team will have them in their possession when in the field

The hazards that may be associated with chemical contaminants can be assessed through comparison of measured or estimated personnel exposures to established occupational exposure limits. Permissible exposure limits (PELs) are established by the Occupational Safety and Health Administration (OSHA), while recommended exposure limits (RELs) are established by the National Institute for Occupational Safety and Health (NIOSH). Immediately dangerous to life and health (IDLH) concentrations are also established by NIOSH. Threshold limit values (TLVs) and time-weighted averages (TWAs) are established by the American Conference of Governmental Industrial Hygienists (ACGIH). PELs may be expressed as an 8-hour TWA or as a ceiling limit. Ceiling limits may not be exceeded at any time and are enforceable by law. RELs are published guidelines that set employee exposure limits for airborne contaminants. RELs are expressed as a TWA or ceiling limit. The ACGIH TLV/TWA is the airborne concentration of a substance to which nearly any worker may be repeatedly exposed 8 hours per day, 40 hours per week, without experiencing adverse health effects. For some substances, the overall exposure to a substance is aggravated by contact with skin, mucous membranes, or the eyes. Other substances have a ceiling value that may not be exceeded during any part of the workday. An IDLH concentration is the maximum airborne concentration of a substance that one could escape within 30 minutes without impairing symptoms or irreversible health effects. It is not anticipated that Stantec personnel will be exposed to airborne contaminants above regulatory limits if prudent work practices, including dust control, are employed during the sampling event(s).

Extensive sampling has been undertaken in many areas of the Southeast Idaho Phosphate Resource Area to date by Stantec (formerly MWH) and P_4 Production, the IMA companies, and regulatory agencies. Based on area history, the events that prompted this investigation, and sampling to date, naturally occurring selenium, arsenic, cadmium, and other trace elements in the phosphate ore body could potentially pose a hazard to sub-populations. Empirical evidence and evaluation of existing data indicate that there is minimal risk to human receptors such as recreational users off of the mine. Exposures to employees implementing the scope of work covered by this plan are substantially less and thus, there is no reasonable possibility for employee exposure to safety or health hazards associated with these substances. Table 2-1 presents occupational exposure limits and toxicological information for selenium and for other metals that could be present at the sampling sites.

In addition to the naturally occurring elements discussed above, field personnel will use a variety of chemical standards in the calibration of their field instruments. These include solutions for calibrating: conductivity (potassium chloride), pH-4, pH-10, oxidation-reduction potential or ORP (potassium chloride, potassium ferrocyanide trihydrate, potassium ferricyanide), and a calibration check (Quick Cal™) solution (potassium dihydrogen phosphate, potassium chloride, sodium hydroxide, potassium ferrocyanide trihydrate, potassium ferricyanide). These chemicals are generally non-toxic and non-corrosive, but nitrile gloves and safety glasses should still be worn when handling. All MSDSs can be found in Appendix C.

Field Personnel also are in contact with small (but still dangerous) amounts of nitric acid used for sample preservation in water samples. Nitrile gloves and safety glasses should ALWAYS be used, and extreme care should always be taken when opening sample bottles; at high altitudes, bottles can become pressurized and acid can be released violently when opened. Nitric acid is an extremely corrosive oxidizer and will cause severe burns to skin and even clothing. Fumes are toxic, and employees should therefore avoid breathing in fumes directly.

Field measurements of nitrite and ferrous iron in groundwater samples require the use of chemical reagent packets. Nitrite reagents are composed of a variety of compounds, predominantly potassium phosphate, and ferrous iron reagents are composed of 1,10 – phenanthroline and sodium bicarbonate. Nitrile gloves and safety glasses must be donned while using either reagent.

When field equipment must be used that is not station-dedicated (i.e. the use of trowels and scissors during soil and vegetation sampling), equipment must be decontaminated with a phosphate-free detergent solution between uses. No safety hazards are anticipated when handling the solution, but when concentrated detergent is handled, nitrile gloves and safety glasses should be used and caution should be taken.

During well installation and test pitting there is the possibility of hydraulic fluid/oil leaks or spills from drill rigs and excavators/backhoes. Stantec personnel must ensure that contractors are capable of containing the release in such an event. Drillers often use liquid "drilling detergent" to increase the viscosity of the drilling fluid (typically water). Drillers typically use Dawn™ liquid dishwashing soap. While this is a relatively safe household item, safety glasses should be worn in the case of splatter.

TABLE 8-1

OCCUPATIONAL EXPOSURE LIMITS AND TOXICOLOGICAL PROPERTIES FOR POTENTIAL CHEMICAL EXPOSURE HAZARDS

Contaminant	OSHA PEL (mg/m^3)	NIOSH REL (mg/m^3)	ACGIH TLV (mg/m^3)	ACGIH / OSHA STEL	OSHA/NIOSH IDLH (mg/m^3)	IP (eV)	Route of Exposure	Symptoms of Exposure
Antimony	0.5	0.5	0.5	NA	50	NA	INH, ING, CON	Irritation eyes, skin, nose, throat, mouth; cough; dizziness; headache; nausea, vomiting, diarrhea; stomach cramps; insomnia; anorexia; unable to smell properly
Arsenic	0.01	0.002	0.01	NA	5 (Ca)	NA	INH, ING, CON, ABS	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, resp irritation, hyperpigmentation of skin.
Cadmium	0.005 (see 29 CFR 1910.1027)	Ca (lowest feasible)	0.01 & 0.002 (respirable fraction)	NA	50	NA	INH, ING	Pulmonary edema, dyspnea, cough, chest tightness, pain, headache; chills, muscle aches; nausea, vomiting, diarrhea; emphysema, mild anemia
Molybdenum (soluble compounds as Mo)	5	NA	0.5 (respirable fraction)	NA	NE	NA	INH, ING	In animals: irritant to eyes, nose and throat; anorexia; diarrhea; weight loss; listlessness; liver and kidney damage.
Nickel (soluble compounds as Ni)	1	0.015 (Ca)	0.1	NA	10 (Ca)	NA	INH, ING, CON	Headache, vertigo; nausea, vomiting, epigastric pain, substernal pain; cough, hyperpnea; cyanosis; weakness; leukocytosis, pneuitis; delirium, convulsion.
Selenium	0.2	0.2	0.2	NA	NA	NA	INH, ING, CON, ABS	Irritant to eye, nose and throat; visual disturbance; headache; chills, fever; dyspnea, bronchitis; metallic taste, garlic breath, gastro-intestinal disturbance; dermatitis; and skin, eye burns.

Contaminant	OSHA PEL (mg/m³)	NIOSH REL (mg/m³)	ACGIH TLV (mg/m³)	ACGIH / OSHA STEL	OSHA/NIOSH IDLH (mg/m³)	IP (eV)	Route of Exposure	Symptoms of Exposure
Thallium	0.1	0.1	0.1	NA	15	NA	INH, ING, CON, ABS	Nausea, diarrhea, abdominal pain, vomiting; ptosis, strabismus; peri neuritis, tremor; retrosternal (occurring behind the sternum) tightness, chest pain, pulmonary edema; convulsions, chorea, psychosis; liver, kidney damage; alopecia; paresthesia legs
Vanadium (as Vanadium pentoxide)	0.5	0.05	0.05	0.5 (ceiling value)	1	NA	INH, ING, CON	Irritant to eyes; green tongue, metallic taste, eczema; cough; fine rales, wheezing, bronchitis, dyspnea; irritant to the throat

ACGIH-American Conference of Governmental Industrial Hygienists

Ca-NIOSH considered carcinogen

CFR-Code of Federal Regulations

CON-Skin or mucous membrane contact

eV-Electron volts

IDLH-Immediately dangerous to life or health

ING-Ingestion

INH-Inhalation

IP-Ionization potential

NA-Not applicable or available

NE-Not established

NIOSH-National Institute of Occupational Safety and Health

OSHA-Occupational Safety and Health Administration

PEL-Permissible exposure limit

REL-Recommended exposure limit

STEL-Short term exposure limit

TLV-Threshold limit values

8.5 ENVIRONMENTAL HAZARDS

There are a variety of environmental hazards including:

- Cold climates
- Heat Stress
- Dehydration
- Dust
- Extreme weather
- Fire
- Geologic hazards
- Ground disturbance
- High altitudes
- Naturally Occurring Radioactive Materials
- Spill of hazardous materials
- Sunburn

The subsections below briefly describe each of the above hazards and the control measures for each.

8.5.1 COLD CLIMATES

On days of low temperature, high wind, and humidity, anyone can suffer from the cold. Severe exposure to cold can be life threatening. Several factors increase the harmful effects of cold: being very young or very old, wearing wet clothing, having wounds or fractures, smoking, drinking alcoholic beverages, fatigue, emotional stress, and certain diseases and medications. Stantec SWP 114 details our requirements for working in Cold Environments.

Cold weather injuries may be local or systemic. Local cold weather injuries include chilblains (chronic injury of the skin and peripheral capillary circulation) and frostbite. Frostbite occurs in three progressive stages: frostnip, superficial frostbite, and deep frostbite. Systemic cold injuries associated with hypothermia affect the entire body system. Hypothermia is caused by exposure to cold and is aggravated by moisture, cold winds, fatigue, hunger, and inadequate clothing or shelter.

Precautionary measures that will be taken to prevent or mitigate cold stress will include:

- Providing field shelters or wind screens.
- Monitoring temperature and wind speed to determine appropriate safety measures.
- Adjusting work schedule based on weather conditions and temperature.
- Providing insulated clothing for field workers.
- Adhering strictly to the buddy system so that workers can monitor for symptoms of cold stress in their co-workers.

Frostbite Monitoring

Frostbite is a potentially crippling condition that can occur when inadequately protected skin or body parts are exposed to freezing weather. Team members should continually be alert for signs of frostbite in co-workers and bring any occurrences to the attention of the SSHO. A cold feeling, pain, and numbness precede the onset of frostbite. Frostbite usually appears as gray or white waxy spots on skin. Areas most susceptible to frostbite are the nose, ears, and cheeks.

The following steps should be taken to avoid frostbite:

- Dress warmly;
- Wear layers of clothes;
- Keep boots and gloves loose-fitting;
- Stay dry;
- Carry extra clothing;
- Avoid touching cold metal with bare hands; and
- Avoid spilling cold fuel, alcohol, or other liquids that freeze below 32°F on your body or clothing.

If a person is frostbitten, get them to a hospital as soon as possible. If transport to a hospital is not immediately available, get the person to a warm shelter and immediately perform the following:

- Cover exposed areas with additional clothing;
- Wrap the person in blankets or a sleeping bag;
- Give the person warm, non-alcoholic drinks;
- Undress the frozen part and submerge the frozen part in a tub of warm water (102° F to 105°F), or put the frostbitten person in a large tub of warm water, if available, and stir the water;
- Warm with skin to skin contact, such as placing warm hands on frozen nose or ears, (but do not rub); and
- Get the person to a hospital as soon as possible.

Do not rub the frozen part; do not give the person liquor; do not allow the person to walk on thawed feet; do not let the person smoke; do not break any blisters that may form; do not let the thawed part freeze again; and do not warm the frozen part in front of a source of dry heat, such as an open fire or oven.

Hypothermia Monitoring

Hypothermia is a lowering of the body's temperature due to exposure to cool or cold temperatures. Field personnel should be continually alert for signs of hypothermia in co-workers and bring any signs of hypothermia to the attention of the SSHO. Most cases of hypothermia occur at temperatures between 30°F and 50°F. Hypothermia is a medical emergency: if not properly treated, hypothermia can cause death. Safety equipment for hypothermia should include a synthetic sleeping bag and a hypothermia thermometer. Personnel suffering from hypothermia should be transported to a hospital as soon as possible, even if they appear to be recovering.

To prevent hypothermia:

- Eat well prior to exposure;
- Dress warmly; and
- Avoid becoming wet through sweating, rain or snow, or falling in water.

Early signs of hypothermia may include violent shivering, slurred speech, a loss of coordination, confusion and an inability to answer simple questions, unusually irritable or strange behavior, or a tendency to drop or lose clothing or equipment. As hypothermia progresses into more serious stages, the victim typically develops trouble seeing clearly, becomes sleepy and numb, and begins to move with difficulty. Eventually, the victim will lapse into unconsciousness if not properly cared for.

The following actions should be taken to treat a hypothermia victim:

- Get the victim to a warm, dry shelter as soon as possible;
- Remove any wet or cold garments and dry the person thoroughly; and
- Wrap the victim in blankets, sleeping bags, or dry clothing to prevent more heat loss.

If a warm area is not available, build a shelter and put the victim in the warmest, driest area available. Remove any wet or cold garments and have one or more persons remove their clothing and lay next to the victim, providing skin to skin contact. Then, wrap the victim and rescuers in dry, warm blankets, sleeping bags, or clothing. When the victim becomes conscious, place warm objects along the victim's sides to warm vital areas. When the victim is able to swallow easily, provide warm, sweetened drinks and food, preferably candy or sweets. Do not give the victim alcohol or allow the victim to smoke, do not rub the victim's skin, and keep checking the victim and providing additional assistance as needed.

8.5.2 HEAT STRESS

The stress of working in a hot environment can cause a variety of illnesses, including heat exhaustion or heat stroke; the latter can be fatal. The use of PPE can increase heat stress significantly, although heat stress can overcome people wearing regular, permeable work clothing, as well. To reduce or prevent heat stress, frequent rest periods and the intake of salts and liquids to conserve and replace body fluids may be necessary. Stantec SWP 113 details our policy for working in Hot Environments.

Personnel should recognize the symptoms of heat stress and take appropriate action on recognition. Some of the symptoms that indicate heat exhaustion are:

- Clammy skin
- Lightheadedness
- Slurred speech
- Rapid pulse
- Weakness, fatigue
- Confusion
- Fainting
- Nausea (vomiting)

If these symptoms are noted, the following steps should be taken:

- Remove the victim to a cool and uncontaminated area;
- Remove protective clothing; and
- Give water to drink, if conscious.

Symptoms that indicate heat stroke include:

- Staggering gait
- Hot skin, temperature rise (yet may feel chilled)
- Incoherent, delirious
- Mental confusion
- Convulsions
- Unconsciousness

If these symptoms are noted, the following steps should be taken:

- Remove victim to a cool, uncontaminated area;
- Cool the victim, whole body, with water, compresses and/or rapid fanning;
- Give water to drink, if conscious; and
- Transport the victim to the designated medical facility for further cooling and monitoring of body functions.

HEAT STROKE IS A MEDICAL EMERGENCY!

8.5.3 DEHYDRATION

Dehydration occurs when a person does not consume enough water, and the effects of dehydration may be exacerbated at high elevations or in dry climates. Bring at least two liters of water per person each day. Workers should continue drinking water throughout the day. Workers completing strenuous activities may require more than this amount each day to stay hydrated. It is important to hydrate the day before work commences as well (i.e. drink at least a liter of water the day prior). An individual is at higher risk of altitude sickness if they are dehydrated. See Safe Work Practice 113 Heat Stress for more details.

8.5.4 DUST

Vehicles and equipment moving through the project site have the potential to produce dust, especially if dry conditions exist. Slow driving speeds and limited movement of vehicles and equipment around the site will help mitigate dust. If extended dry conditions exist and dust becomes a problem, watering down the road and/or work area can be performed. When possible field personnel should be located up-wind of any dust creating tasks (i.e. test pitting, drilling, grading).

8.5.5 EXTREME WEATHER

Stantec uses the following approach to assessing and managing the risks from inclement weather and thermal stress. The basic elements include

- Monitoring weather conditions using a weather station that is part of the National Oceanic and Atmospheric Administration (NOAA) weather radio all hazards network or similar notification system.
- Develop a monitor plan based on the guidance for management of heat and cold stress found in the current year American Conference of Industrial Hygienist's (ACGIH's), *Threshold Limit Values and Biological Indices*.
- Monitor ambient conditions using wind chill for the management of cold stress.

The following actions should be followed in the case of severe weather.

Before the severe weather or natural disaster occurs:

- Find a way to monitor real-time Information (television, AM/FM radio, the Internet, NOAA All-Hazards Radio).
- Prepare an Emergency Action Plan that identifies evacuation routes, shelter-in-place options and hazard-specific responses.
- Identify a safe shelter area and stock with emergency supplies. Generally, the best safe shelter areas will be in the interior of buildings away from windows. Tornado shelters should be below ground (basements). Shelters from flooding should be on high ground.

EARTHQUAKE AND DISASTER PREPAREDNESS

If an earthquake or natural disaster occurs during working hours and the magnitude is such that field personnel may be in danger, the Stantec SSHO will initiate the site evacuation procedure. This action is to be taken only if in the judgment of project personnel and/or SSHO the earthquake is large enough to have potentially caused damage to any of the structures or equipment being used on the site. If the earthquake or disaster occurs during non-working hours, the SSHO will determine whether safe entry onto sampling locations can be made, or if an inspection is needed first. If at any time the inspection team feels that they need the assistance of the fire department, the inspection shall cease until the fire department is able to assist. The inspection will be conducted using the buddy system. The team will look at structures, equipment, and any chemical storage areas for signs of cracks or deterioration. When assessing areas known to contain chemicals, appropriate air monitoring equipment will be used to ensure that leaks are detected quickly and without injury to the inspection team. When inspecting areas where chemical releases could have occurred as a result of a breach of containment, Level B PPE is recommended

LIGHTNING

Lightning monitoring will consist of cell phone emergency alerts. Lightning is common during the summer months when the work will be conducted.

- If you can hear thunder, you are within 10 miles of a storm and are in danger. This is the time to seek shelter.
- Buildings that are not equipped with grounded plumbing or electrical wiring are unable to conduct electrical current and do not offer protection from lightning. This means that you are still vulnerable if you seek shelter in a bus stop, shed, pavilion, etc.
- An automobile can offer protection from lightning by acting like a Faraday cage, provided that the occupants do not touch the metal of the car while inside (i.e., doors, dashboard).
- Stay away from tall objects if caught in a lightning storm. Trees are one of the worst forms of shelter from lightning. They offer a false sense of security and, if anything, attract lightning.
- Sometimes lightning will give you a few seconds of warning before a strike such as: hair standing on end; skin tingling, light metal objects vibrate or buzz; metallic taste in your mouth; sweaty palms; crackling or "kee kee" sound; smell of ozone; blue glow around objects at night.
- If caught outside, separate yourself from others, cover your ears (to protect against noise), squat with feet together and only the feet touching the ground, **do not lie flat on the ground**.

- **Remember there is no safe place outside during a thunderstorm**.

The SSHO will actively monitor weather conditions, forecasts, and NOAA emergency alerts. Work will be stopped and/or postponed if a thunder storm approaches the project site. Work will also be stopped immediately if any person hears thunder and personnel will shelter in the structures at the parking area near the left abutment, or will leave the site entirely. Work may resume again if thunder is not heard for a period of at least 30 minutes, per recommendation of the National Lightning Safety Institute, and if weather reports indicate that storms are not expected to continue for the remainder of the day.

If a lightning storm is suspected or observed, site activities must be stopped, and site equipment must be evaluated for its potential for acting as a lightning rod. Personnel should wait indoors for the storm or lightning event to end. If the strike of lightning occurs and personnel are out in the field, the response should be to disband from one another and lay low to the ground by dropping to your knees and bending forward with your hands wrapped around your knees, away from any poles or trees.

Persons struck by lightning will receive a severe electrical shock and may be burned, but they carry no electrical charge and can be handled safely. Someone who appears to have been killed by lightning often can be revived by prompt action. Those unconscious but breathing probably will recover spontaneously. First aid and CPR should be administered as appropriate until medical assistance arrives. Realize that victims who appear to be only stunned or otherwise unhurt also need attention. Check for burns, especially at fingers and toes and next to metal buckles, jewelry, or personal items that the victim is wearing. Remember to treat for shock

TORNADO AND HIGH WIND WARNING

Allow yourself plenty of time to get to your tornado shelter. This is EXTREMELY important. If you are outside, get inside. If you are already inside, get as far into the middle of the building as possible.

Workers should seek shelter in their vehicles if no substantial permanent structures are available nearby. The structures near the parking area are NOT considered adequate tornado shelters.

Tornadoes usually develop from thunderstorms and normally occur at the trailing edge of the storm. Most tornadoes occur in the months of April, May, June, and July in the late afternoon and early evening hours.

When storms are predicted for the project areas it is necessary to monitor weather conditions on a radio. A tornado watch is issued when favorable conditions exist for the development of a tornado. A tornado warning is issued by the local weather service office whenever a tornado has actually been sighted or is strongly indicated by radar.

If a tornado warning is issued, seek shelter immediately. If there are permanent buildings located on site, enter one immediately and move toward interior hallways or small rooms on the lowest floor. Get underground if possible. If you cannot, go to the lowest floor possible. Flying and falling debris are a storm's number one killer. Use pillows, blankets, coats, helmets, etc. to cover up and protect your head and body from flying debris. DO NOT open doors or windows. This does not help! DO NOT go outside to find the tornado, even if you think it is far away!

If a tornado warning is issued and you are in a vehicle or a site trailer, leave and go to the nearest building. If there are no buildings nearby, go in the nearest ditch, ravine, or culvert, with your hands shielding your head. DO NOT seek shelter under a highway overpass. They are not safe!

If a tornado is sighted or a warning issued while you are in open country, lie flat in a ditch or depression. Hold onto objects secured to the ground, such as a bush or fence post, if possible.

Once a tornado has passed the site, field personnel are to assemble at the designated assembly area to determine if anyone is missing or injured. Administer first aid and seek medical attention as needed.

WINTER STORMS

When snow or ice storms are predicted for the project area, field personnel should monitor radio reported weather conditions. A winter storm watch is issued when a storm has formed and is approaching the area. A winter storm warning is issued when a storm is imminent and immediate action is to be taken.

When a storm watch is issued, monitor weather conditions and prepare to halt site activities. Notify the Project Manager or FTL of the situation. Seek shelter at site buildings or leave the site and seek warm shelter.

If you are caught in a severe winter storm while traveling, seek warm shelter if road conditions prevent safe travel. If you are stranded in a vehicle during a winter storm:

- Stay in the vehicle. Disorientation comes quickly in blowing and drifting snow.
- Wait for help.
- Keep a window open an inch or so to avoid carbon monoxide poisoning.
- Run the engine and heater sparingly.
- Keep watch—don't let everyone sleep at the same time.
- Exercise occasionally

8.5.6 FIRE

Wildfires and brush fires are a threat to areas with dry conditions and tall grasses. Wildfires have occurred in nearby areas but the level of danger varies. Precautionary measures need to be taken in order to reduce the risks to fire. Driving through tall grasses should be avoided as much as possible, as the heat from a truck or vehicle exhaust on dry grass could spark a fire. When work around tall grasses cannot be avoided, the area should be wetted to reduce fire risks. Up to date fire extinguishers shall be kept near each piece of equipment on site and workers shall be properly trained on how to operate them. See additional information in Section 13.

8.5.7 GEOLOGIC HAZARDS

Geologic hazards, including landslides, debris flows, and rock fall, may be present at the site. Potential landslide and debris flow areas may exist on slopes with unstable soil or rock conditions. Springs, seeps, or saturated soils may increase the likelihood of these events or a large precipitation event could trigger one of these hazards. Rock fall may occur in mountainous regions along rock slopes. Workers should wear head protection when near these slopes. See Safe Work Practice 416 Supervision of Contracted Drilling Activities for more details.

8.5.8 GROUND DISTURBANCES

There is a potential for the ground to be torn up by vehicles and the movement of heavy machinery, especially in areas of soft soil or difficult terrain. In the case where large tire ruts form or the ground is torn up, workers shall backfill them and flatten the area. Special attention to site conditions should be taken after long periods of rain or snow. Vehicles shall not be taken through areas that are excessively muddy or saturated with water, as large ruts can form and the ground can be scarred.

8.5.9 HIGH ALTITUDES

Although the site is located at an elevation of about 6,000ft, altitude sickness could still occur, which presents a potential risk to workers. Altitude sickness occurs when a person cannot get enough oxygen due to lower oxygen content of the air at the project site. This is a particular concern for personnel who will be traveling to the site from much lower elevations. Symptoms of altitude sickness include headache, loss of appetite, nausea, dizziness, tiredness or weakness, and insomnia. If symptoms are moderate to severe, go down in elevation as soon as possible and drink plenty of water. Emergency help may be required for severe cases if the person is confused or unable to walk straight.

Altitude sickness is preventable. Drink plenty of water for several days in advance of the field work to help reduce the risk and/or severity of altitude sickness. Symptoms of altitude sickness may be exacerbated by hunger, lack of sleep, dehydration, or performing strenuous activities. Workers should take plenty of breaks while working on-site, especially during the first day of work.

8.5.10 NATURALLY OCCURRING RADIOACTIVE MATERIALS (NORM)

Phosphate ore in the southeast Idaho Phosphate Resource Area has slightly elevated levels of naturally occurring radioactive materials (NORM) that produce ionizing radiation. Most notable is the isotope ^{238}U. Natural background in soils vary significantly throughout the United States but generally ranges from 2 to 10 picocuries per gram (pCi/g), whereas phosphate ore contains 23 to 28 pCi/g. In addition, the ^{238}U found in ore is in equilibrium with all of its decay daughters, including radium, radon, and polonium (i.e., all of the decay daughters would be expected to range from 23 to 28 picocuries per gram in the ore as well). This level of radiological activity does not pose a threat to persons on a mine site. However, certain common- sense precautions are worth noting. These precautions are similar to those used to prevent exposure to other trace elements in media being sampled, i.e., avoid inhalation and ingestion. The precautions include:

- Avoid breathing dusts;
- Do not eat and drink in dusty areas;
- Use proper hygiene techniques such as washing your hands prior to eating;
- Change clothing daily if clothing becomes soiled with ore. Note that clothing can be washed normally to remove the ore; and,

- If using a respirator, ensure that you keep the respirator clean.

8.5.11 SPILL OF HAZARDOUS MATERIALS

Apart from water, there will be limited amounts of other fluids used on site as outlined in Section 8.4. Spills are possible due to leaks or spillage of fuels and lubricants associated with vehicles, mobile equipment and the drilling equipment.

On site personnel will mobilize a minimum of 50 pounds of absorbent material to assist in rapid containment of small spills. In the event of a hydrocarbon spill the following items will be completed.

- First aid will be administered to injured or contaminated persons
- Workers on site will keep general public out of the contaminated area
- Operators and/or workers will stop the spill at the source without taking unnecessary risk. This could involve activities such as closing a valve or temporarily sealing a hole with a plug.
- The spill will be contained through use of absorbent materials
- P_4 Production Project Manager will be notified of the nature and quantity of spilled material, primary containment measures, personnel injuries and potentially life threatening hazards.

Spilled material will be contained and absorbed using absorbent materials such as oil dry "PowerSorb" or equivalent materials. Absorbed materials will be placed in DOT approved 55-gallon steel drums pending proper disposal as coordinated through environmental services.

8.5.12 SUNBURN

Excessive sun exposure can cause skin damage, and in some cases may cause skin cancer. People with fair skin, freckles, and red or blond hair are most at risk but workers should use sun protection. Wear protective clothing such as long sleeves and a brimmed hard hat to cover your neck, ears and face. Use sunscreen with a sun protection factor of at least 15 and reapply often. Use precaution even on cloudy days because about 70 to 80 percent of the sun's UV rays still come through the clouds. Some medications can make skin more sun sensitive, so check with your doctor.

8.6 PHYSICAL HAZARDS

Physical hazards associated with working in areas near active mine sites as well as those associated with persons working out-of-doors in a mountainous terrain probably pose the greatest threat to field personnel on this project. The physical hazards that may be encountered will vary according to the type of site being investigated. Active mines pose hazards that are specific to mine operations, including the operation of heavy equipment, blasting, and the possibility of mine wall collapse

At other sites, hazards associated with collecting samples are likely to be minimal. Traveling by foot through, or collecting samples in, pasture land, cropland, or forest, possible hazards may be largely limited to slipping, tripping, and falling. It is important that proper footwear is always worn, and that care and common sense is always used while walking to and from stations. Safety glasses are also required while collecting soil and vegetation samples due to the possibility of dust or other debris blowing into the eye. While hiking to and from a sample location, it is also a good idea to wear eye protection to protect from tree branches and other eye-level hazards. Stream sampling can pose risks associated with loss of balance, including head and limb injuries, scrapes, hypothermia, and drowning. Personnel will need to use good judgment to determine whether it is safe to enter a body of water. In particular, while sampling from streams or rivers, field personnel should be aware of hazards that may be created by high or turbulent water, including being swept out by the current. Additionally, field personnel should be aware of hazards that may be created by stepping in deep, soft sediments, or floating debris.

Travel to remote areas engenders additional hazards specific to the method of travel. Hazards associated with foot travel include muscle strains and sprains, dehydration, heat or cold stress, and slips, trips, and falls. If a sample location cannot be reached by vehicle, and a significant hike is required, precautions must to be taken to ensure that field personnel are properly protected from the weather, whether it is heat stress or cold stress. Hazards associated with vehicle transport include flat tires, getting the vehicle stuck, and other miscellaneous vehicle malfunctions. It is essential that both the vehicle operator and vehicle passengers are cautious and observant of on/off road obstacles and dangers. Operator and passengers should also carry a 2-way radio and cell phone or satellite phone (if available) with them at all times and know how to change a flat tire on the vehicle.

Travel in remote areas can also pose hazards that are best countered by acquiring knowledge of wilderness safety, awareness of methods for handling contact with animals, and by safely operating equipment. Specific hazards associated with travel in remote areas are listed in Appendix A, *Activity Hazard Analysis*, together with recommended practices and procedures to minimize risks to Stantec and subcontractor field personnel. Table 8-2, *Ten Essentials for Wilderness Travel* lists the ten essential items that field personnel should always have with them when working in remote areas.

Overseeing well installation and test pit excavation and collection of samples during these activities presents a unique set of physical hazards due mainly to the heavy machinery used. Hearing protection is essential as well as hard hats and safety glasses to protect from flying debris caused. Long hours in one location on hot, sunny days present a challenge in staying cool while donning required PPE. Sunscreen, light colored clothing, and replenishing fluids are essential. Taking refuge inside of a vehicle may be acceptable if the drilling/test pit tasks are not compromised. Furthermore, hands should be kept away from all moving parts and care should be taken when walking around these sites to avoid slips, trips, and falls.

In addition to working near heavy machinery, entering a test pit to collect undisturbed samples presents its own hazards and should only be performed under the conditions outlined in SOP-08 (Appendix A of the Work Plan). Furthermore, personnel should not approach the excavator when in operation and should only proceed into the swing radius of the excavator following signals from the operator which will be discussed prior to start of work in accordance with SOP-08 (Appendix A of the Work Plan).

Table 8-2 Ten Essentials for Wilderness Travel		
To Find Your Way	**For Your Protection**	**For Emergencies**
Map of the area **Compass and/or GPS(with sufficient backup battery)** Flashlight or headlamp	Sunglasses Extra food and water Extra clothing	Waterproof matches Candle, fuel tablets, or other long–burning fire starter Pocket knife First aid kit

Low-flow well sampling also presents unique physical hazards. Compressed nitrogen gas is often used to provide air pressure and the large storage cylinders can be difficult to manage. Cylinders are to be stored in a secured upright position at all times, in temperatures not exceeding 52º C (125 º F), and valves should be closed whenever not in use (even if empty). Cylinders should not be dropped, rolled, or dragged, and should be transported using a suitable hand truck. Additional information can be found in Appendix C in the Nitrogen MSDS.

Portable gasoline powered generators may also be used to power air compressors to provide air pressure during low-flow well sampling. Portable generators should only be used in wide open spaces; carbon monoxide poisoning from the toxic engine exhaust is deadly. Gasoline for the generator must only be stored in flammable liquid safety cabinets and should only be used to refuel the generator after it has been turned off and allowed to cool. Gasoline spilled on hot engine parts could ignite. Additional safety information can be found in Appendix D

The following physical hazards are discussed below:

- Drilling
- Driving
- Foot traffic – Slips/Trips/Falls
- Hand and power tools
- Mobile equipment
- Manual material handling
- Mine structure instability
- Noise exposure
- Traversing irregular and steep terrain
- Working at height

The subsections below briefly describe each of the above hazards and the control measures for each.

8.6.1 DRILLING

Drilling operations are a fundamental component of this project and are subcontracted to a qualified drilling team. SWP 416 – Supervision of Contracted Drilling Activities has been developed to direct project personnel with the duties and responsibilities associated with overseeing safe operations. All personnel are required to read and understand this SWP.

Drilling hazards include slip, trips and falls associated with remote and unimproved terrain. Overexertion (strain/sprain) from manual material handling of equipment. Struck by/against and caught between hazards associated elevated objects, moving equipment, and rotating components associated with clearing and grubbing of land and the components of the drill rig. Impact, inhalation, contact and injection hazards associated with rupture and leaking high pressure air and hydraulic systems. Burns associated with hot exposed surfaces from the drill engine and drive train. And noise, weather, biological and wildlife related hazards addressed in this HASP and the associated AHA's in Appendix A.

All drilling operations must consider the location of all potential under and above ground utilities and take all precautions associated with SWP 213 – Utility Clearance Practice.

Stantec personnel will not be directly involved in drilling operations and will observe from a safe distance. Our primary hazards are associated with handling and collection of the geotechnical samples. Safe lifting practices and situational awareness of surroundings are the primary defense.

8.6.2 DRIVING

SWP 124 – Safe Driving has been developed to detail the Stantec requirements for driving on behalf of company related business. All Stantec employees are expected to be familiar with this SWP and observe the requirements. Green Defensive Driver Training is required.

Motor vehicle accidents can occur any time people drive. On mine sites, large haul trucks may travel at relatively high rates of speed and pose a unique traffic threat to anyone traveling on haul roads. Railroad trains are also used at mines to haul ore to processing plants and pose railroad crossing hazards. Field personnel working on or around mine traffic areas should be especially mindful of mine-related traffic and mine-specific traffic rules. Field personnel are required to employ defensive driving techniques and obey site speed limits, posted traffic control signs, and vehicle safety requirements. Accidents are to be reported to the Stantec SSHO. Working in an active mine area poses unique hazards to personnel whether in a vehicle or as a pedestrian. Mine equipment, especially haul trucks, are often large, may operate at relatively high rates of speed, often have limited visibility, and cannot stop or maneuver like over-the-road vehicles. Unique mine driving rules often apply within a local mine that are different from public road rules. Haul trucks within a mine area often have the right-of-way in every instance. Therefore, it is extremely important that while walking or driving within an active mine area, to be exceptionally alert to all traffic around you. When in doubt, yield the right-of-way. **Field personnel are required to wear seatbelts at all times when in a moving vehicle and the driver must refrain from using his/her cell phone.**

8.6.3 FOOT TRAFFIC – SLIPS, TRIPS AND FALLS

The field investigation will take place on rugged and rocky terrain. Field personnel are to be vigilant in providing clear footing, clearly identifying obstructions, holes, or other tripping hazards and maintaining an awareness of uneven terrain and slippery surfaces. It is necessary that shoes providing more elaborate tread be worn to minimize slip, trip and fall hazards

8.6.4 HAND AND POWER TOOLS

SWP 206 – Hand and Portable Power Tools has been developed to describe the safe work practices required by all Stantec employees who will utilize hand and power tools. All Stantec employees are required to read, be familiar with, and abide by all the requirements detailed in the SWP in additional to the manufacturer's recommendations. All tools will be properly maintained and inspected prior to each use

8.6.5 MOBILE EQUIPMENT

Stantec SWP 216 – Working Near Mobile Equipment addresses the many hazards associated with working in close proximity to mobile equipment but can be expanded to operational equipment and working in congested areas with concurrent operations. Situational awareness must be practiced by all Stantec employees and their Subcontractors. The Project Manager or Resident Engineer/SSHO will coordinate Stantec project related activities and schedules with the client and communicate these activities to our team when performing the daily Field Level Risk Assessment (RMS 2). Any conflicts must be immediately reported to the Project Manager or SSHO.

8.6.6 MANUAL MATERIAL HANDLING

SWP 115 – Material Handling and Safe Lifting has been developed to provide guidance to Stantec employees for protection of hazards associated with manual material handling. All employees should be familiar with the SWP and exercise the requirements. An Activity Hazard Analysis has also been developed to address these hazards in Appendix C.

During manual lifting tasks, personnel will remember to lift with the force of the load suspended on their legs and not their backs. They are to maintain a straight back and hold the object close to the body. Mechanical lifting devices or the help of a fellow field team member should be sought when the object is too heavy for one person to lift.

8.6.7 MINE STRUCTURE INSTABILITY

Mine wall collapse can occur at inactive mine sites. At some of the older mines, driving or walking near a high wall may pose a significant hazard as well. Field personnel are required to wear hardhats and safety glasses whenever they are in a mine pit, near a high wall, or any other situation in which an overhead hazard may exist. Field personnel must be alert and aware of their surroundings. Therefore, prior to entering an inactive mine site, Stantec personnel must be cautious and aware of any potential instability that could lead to rock slides, the collapse of high walls, and other physical hazards. Stantec personnel will also be acquainted with the signs of instability that could lead to rock slides, the collapse of high walls, and similar hazards

8.6.8 NOISE EXPOSURE

High noise exposure is possible on this project when working near mobile equipment, including stationary drill rigs, impact tools, generators and compressors. Stantec employees are required to stay a safe distance from noise generating operations or participate in the hearing conservation program. Stantec personnel are required to participate in the hearing conservation program if an exposure to noise above a time weighted average of 80 dBA is possible. This must be addressed on the RMS 9 Medical Surveillance form required of all field personnel. The hearing conservation program includes a written program, baseline and annual audiograms, and annual hearing conservation training to instruction and observation of the correct use of hearing protection.

8.6.9 SHARP OBJECTS AND PINCH POINTS

During this site investigation, it is feasible that personnel may encounter sharp edges and pinch points. Sharp objects may include site debris, field tools, equipment, or other objects. Pinch points are places where the hands may be caught between objects or moving parts. When danger of cuts to the hands or other body parts is probable, employees will either arrange paths where personnel may walk without encountering sharp edges or will ensure during the tailgate safety meeting that areas with known sharp edges are brought to the attention of field personnel. Heavy work gloves shall be used in conjunction with any chemical resistant gloves in circumstances where handling sharp objects are required

8.6.10 TRAVERSING IRREGULAR AND STEEP TERRAIN

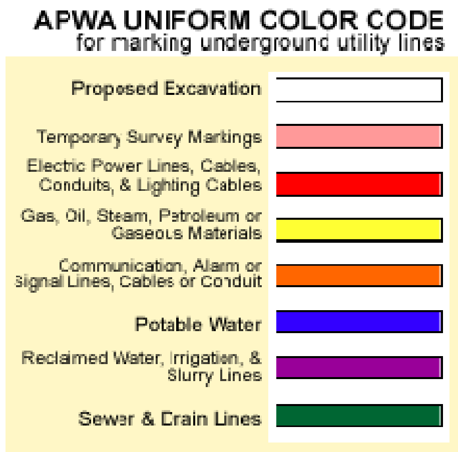
Stantec's procedures for managing the risks presented by walking over rough terrain are set forth in Stantec's HSSE Safe Work Practice (SWP) 105, Personal Protective Equipment.

Employees walking on uneven surfaces must use caution to prevent slips, trips, and falls that can result in twisted or sprained ankles, knees, and backs. If steep terrain or uneven ground must be negotiated, sturdy shoes or boots should be used. Boots shall have a minimum of six inches of ankle support and shall be ties up to the top of the boot to ensure the ankle is properly protected from slips and trips. All boots must have good tread and should be replaced if cracked, torn, or the toe caps are exposed. When working on ice, cleats should be worn on the boots. Work areas should be inspected before work commences and tripping hazards should be removed or clearly marked. Good housekeeping practices should always be employed to keep work areas clean and mitigate new tripping and slipping hazards.

The risks and consequences of slips, trips, and falls are greater when working on a steep slope. Work should only be conducted in areas which are deemed safe for workers to access upon inspection by the SSHO. Workers should be aware of loose footing and underfoot tripping hazards at all times while walking on steep slopes.

8.6.11 UNDERGROUND AND OVERHEAD UTILITIES

Underground and Overhead utilities will not present issues. Should they be encountered the following color codes may be used to identify the specific type of utility.



8.7 SITE CONTROL

Site control is an important part of a field health and safety program. The purposes of site control are to minimize potential worker exposures, protect the public from site hazards, and prevent vandalism of site facilities. Site control procedures that will be implemented during the activities, which are discussed in this section, consist of site security controls and communication systems.

Under no conditions are deviations from safe work practices to be tolerated by anyone on site. If any deviation continues after a reminder of proper procedures or a reasonable warning, the Stantec SSHO will be informed of the circumstances. The Stantec SSHO will attempt to correct the unsafe behavior or unsafe condition. Should this attempt fail, the Stantec SSHO shall halt site activities and dismiss the non-cooperative personnel.

8.8 MULTIPLE-EMPLOYER JOB SETTING

Enforcing safe work practices at a multiple-employer job site presents many challenges. Under OSHA, each employer is required to provide a safe and healthful working environment for its employees (see OSHA poster in Appendix J). Most hazardous waste sites require several contractors to work simultaneously on different project tasks. In this situation, the activities of one company could create hazards for the employees of another company. It is not possible to anticipate every hazard associated with activities at a multiple-employer job site in a Health and Safety Plan. The SSHO must discuss particular safety and health issues that may be associated with each day's activities at the daily tailgate safety meeting.

8.9 SITE SECURITY

Existing site controls that are likely to be encountered during the course of the investigation will vary from no controls to strict property perimeter controls. When possible, client personnel will be requested to investigate any suspicious activities at the field sites. In some cases, an independent security watch may be needed. Security at the sites will be the responsibility of the client during periods of inactivity, including weekends. To maintain security at the sites during working hours, the SSHO will:

- Control site entrances and exits as necessary through the installation of appropriate safety barricades, signs, and/or signal lights.
- Establish a personnel identification system.
- Be responsible for enforcing entry and exit requirements.
- Utilize temporary fencing to control site access, where feasible.
- Post warning signs around the perimeter of the work area, should the use of temporary fencing not be feasible.

To maintain security during nonworking hours, the SSHO will secure the site prior to leaving at the end of a working day and equipment and supplies will be secured or stored in locked facilities.

8.10 COMMUNICATION SYSTEMS

Two general types of communication systems should be available for workers assigned to field projects. One system will ensure adequate communication between field personnel, and the other will ensure the ability to contact personnel and emergency assistance off site. Internal communication will be used to:

- Alert team members to emergencies.
- Pass along safety information, such as weather conditions that could affect heat stress, cold stress or general safety.
- Maintain site control.
- Facilitate site work by being able to call the appropriate party for information without having to decontaminate the work party and equipment and secure the site.

Verbal communication can be impeded by background noise and limitations imposed by PPE. It is therefore vital that pre-arranged signals of communication be arranged prior to the initiation of site activities, particularly when heavy equipment may be operating in the vicinity. Common types of internal communication devices include:

- Radios;
- Noisemakers such as compressed air horns, megaphones, sirens, and whistles; or,
- Hand and arm signals.

External communication systems between on-site and off-field personnel are necessary to:

- Coordinate emergency response efforts,
- Report to upper management about site activities, and
- Maintain contact with essential off-field personnel.

The primary means of external communication are telephones, radios, facsimile machines, and computer networks.

8.11 GENERAL SAFETY RULES

The health and safety program contained in this portion of each Stantec Health and Safety Plan has been developed in accordance with relevant occupational safety and health regulations and requirements and applies to field sites and workplaces. Because this section is intended to be applicable to a wide range of sites and conditions, there may be information in this section that applies to certain areas of the country only.

The following practices are expressly forbidden during site work:

- Smoking, eating, drinking, chewing tobacco, or applying cosmetics while taking samples or while near exposed samples.
- Contact with potentially contaminated substances; walking through puddles or pools of liquid; kneeling on the ground; or leaning, sitting, or placing equipment on contaminated soil.
- Performance of tasks without a buddy; personnel will be required to use the buddy system unless specifically exempted elsewhere in the Health and Safety Plan.

Personnel must keep the following guidelines in mind when performing field activities:

- Hazard assessment is a continuous process. Personnel must be aware of their surroundings and the chemical and physical hazards that are present.

Field personnel will be aware of the physical characteristics of each site, including site access, the location of overhead power lines and underground utilities, wind direction, and the location of communication devices and safety equipment

8.12 SANITATION

Work breaks, eating, drinking, and paperwork tasks will be performed in the field vehicle or other suitable location away from sampling location. Field personnel will wash or otherwise sanitize their hands prior to eating or drinking.

The SSHO is responsible for ensuring that an adequate supply of water is available at the site. During times of heavy labor and hot temperatures, it is recommended that approximately one liter of water per hour be ingested. Sport-type beverages also may be provided for field personnel. It is to be assumed that there is no potable water in the field. When decontamination procedures interfere with the ability of field personnel to obtain sufficient drinking water, personnel may drink water without prior personnel decontamination under the following stipulations:

- Water is dispensed from a cooler with a pull-lever pouring spout. Push-button pouring spouts are unacceptable, as dirty fingers can easily contaminate the pouring spout.
- Minimum three-inch tall disposable drinking cups must be used and discarded after each use.
- Drinking cups must be dispensed out of a plastic or metal dispenser attached to the cooler, allowing the bottom of the cup to be grabbed without touching the top rim.

Bottled water or sports drinks with removable caps, taking care not to touch the drinking surface with potentially contaminated hands.

8.13 ILLUMINATION

All site work will be done during daylight hours, with the exception of driving to and from the work site

8.14 STANDARD EMERGENCY HAND SIGNALS

Team members should be familiar with the following emergency hand signals:

- Hand gripping throat: "Respirator problems, can't breathe."
- Grip team member's wrist or place both hands around waist: "Leave site immediately; no debate!"
- Thumbs up: "OK, I'm all right; I understand."
- Thumbs down: "No, negative."
- Hands on face: "Put on respirator."

8.15 FIRE PREVENTION

Field activities performed during the summer at this location could potentially result in a fire at the site. Cigarette smoking is forbidden at any sampling locations and should be done with care otherwise (extinguished and disposed of properly). Driving off road should be avoided if possible, as vehicles driving over tall stands of brush and grasses can easily spark a fire.

Electrical wiring will be free from frayed ends and sections, and hook-ups will be checked for loose fittings. Portable power tools will be connected to a ground fault circuit interrupter, and care will be taken to ensure that electrical connections do not exceed the maximum load capacity for any one circuit

8.15.1 WILDFIRES

Wide open areas of natural brush present the danger of wildfires. Many project sites have structures that can provide enough of a fire break to prevent a wildfire from endangering field personnel, but such a structure does not provide absolute protection. The Stantec SSHO will therefore check regularly with the local fire department during the most common wildfire months of July through November. Should a wildfire threaten a work site, the Stantec SSHO will watch for changing conditions and evacuate and secure each active site, in accordance with local fire department instructions

8.15.2 FIRE OR EXPLOSION RESPONSE ACTIONS

The actions listed below are in a general chronological sequence. Conditions and common sense may dictate changes in the sequence of actions and the addition, elimination, or modification of specific steps.

Immediate Action. Upon detecting a fire/explosion, employees will notify the fire department and determine whether or not the fire is small enough to extinguish readily with immediately available portable extinguishers or water, or if other fire-fighting methods are necessary. Non-essential personnel will be directed away from the area of the fire. If it is judged that a fire is small enough to fight with available extinguishing media, employees will attempt to extinguish the fire provided that:

- They have been properly trained on the use of the specific fire extinguisher to be used.
- They are able to approach the fire from the upwind side, or opposite to the direction of the fire's progress.
- The correct extinguisher is readily available.
- No known complicating factors are present, such as likelihood of rapid spread, imminent risk of explosion, or gross contamination.

Personnel leaving a fire/explosion area will notify the fire department and will account for employees in that area as soon as possible. The SSHO or designee will perform a head count of sampling team members.

Notification. The Stantec SSHO will be notified as soon as possible of the location, size, and nature of the fire/explosion. A member of the Stantec management team will notify appropriate agency personnel in the event of a fire or explosion resulting in a release of a hazardous material to the environment. As conditions dictate, the SSHO will declare an emergency, initiate the remedial procedures, request assistance from the fire department, and make the necessary on-site and off-site notifications. If assistance from the fire department is required, an escort appointed by the SSHO will direct responders' vehicles over clean roads to the extent possible to limit contamination. Note: National Fire Protection Association (NFPA) guidelines call for notifying the fire department, even for small fires, to ensure proper handling.

Rescue. If personnel are unable to evacuate themselves from a fire/explosion area for any reason, their rescue will be the first priority of responders. The FTL and/or SSHO will determine whether on-site resources are sufficient to proceed, or if rescue must be delayed until outside responders arrive. **Field personnel are not to take any actions which place themselves or other in danger and/or for which they have not been properly trained.**

Fire-Fighting Procedures. Planned fire-fighting procedures are described below. These apply to small fires that the project personnel can control with a clear escape route.

Fire During Working Hours: In the event that a fire occurs during working hours, the following measures will be taken to put out the fire provided that the person is properly trained to do so. These measures are sequential, that is, if the first measure does not succeed in containing the fire, the next measure will be initiated.

- Use fire extinguishers.
- Confirm that request for assistance from the fire department has been made.
- Utilize earth moving equipment, foam unit, and water truck, as appropriate. Brush fires will be extinguished with water.

Fire During Non-Working Hours: In the event of a fire during non-working hours, existing alarms, site security (if applicable), or whomever from the project team is notified, will notify the Stantec SSHO or HSSE ADVISOR. Additional actions will be consistent with procedures established for a fire during working hours.

Response Coordination. Upon arrival of outside responders from the fire department, the SSHO will coordinate with the leader of the outside responders to direct fire-fighting activities;

however, the control of the scene is now the responsibility of the leader of the outside responders.

Protection of Personnel. The primary methods of protecting personnel from fire conditions will be by distance and remaining upwind. Based on the conditions, the SSHO will determine appropriate distances and the selection of personal protective equipment for field personnel.

Decontamination. At the conclusion of fire fighting activities, the SSHO will:

- Determine to the extent practicable the nature of the contaminants encountered during the incident.
- Arrange for outside responders' fire response equipment, and on-site equipment as necessary, to be processed through decontamination, using methods appropriate for the contaminants involved.
- Equipment not easily decontaminated shall be labeled and isolated for further action, such as determining specific contaminants by wipe sampling or awaiting the delivery of specific decontamination media and supplies.

Fire Extinguisher Information. The four classes of fire, along with their constituents, are as follows:

Class A - Wood, cloth, paper, rubber, many plastics, ordinary combustible materials.

Class B - Flammable liquids, gases, and greases.

Class C - Energized electrical equipment.

Class D - Combustible metals such as magnesium, titanium, sodium, and potassium.

Examples of proper extinguishing agents are as follows:

Class A - Water

Water with one percent AFFF Foam (wet water)

Water with five percent AFFF or Fluoroprotein Foam

ABC Dry Chemical

Halon 1211

Class B - ABC Dry Chemical

Purple K

Halon 1211

Carbon Dioxide

Water with six percent AFFF Foam

Class C - ABC Dry Chemical

Halon 1211

Carbon Dioxide

Class D - Metal-X Dry Chemical

No attempt should be made to extinguish a large fire. Large fires should be handled by the fire department. The complete area of the fire should be determined. If human life appears to be in danger, or the spread of the fire appears to be rapidly progressing, move personnel further upwind and away from the fire. Do not attempt to extinguish even a small fire if you have not been properly trained to do so.

Use of Fire Extinguishers. Inspect the fire extinguisher on a monthly basis to ensure that the unit is adequately charged with extinguishing media. Do not store a fire extinguisher on its side. To use the extinguisher, follow the acronym PASS for instructions listed below:

1. **P**ull the pin on the top of the unit.
2. **A**im at the base of the fire.
3. **S**queeze the handle on the top of the unit.

Sweep the extinguishing media along the base of the fire until the fire is out. Ensure that the fire is fully cooled before assuming it is completely extinguished.

9.0 PERSONAL PROTECTIVE EQUIPMENT

9.1 PERSONAL PROTECTIVE EQUIPMENT

The Environmental Protection Agency (EPA) designations of Levels D, C, B and A for PPE are used to describe the general PPE ensembles that may be employed during hazardous waste site operations. These ensembles are depicted in Figure 6-1. Based on site contaminant information and established exposure limits, Level D has been selected as the level of protection appropriate for field personnel during this investigation. Field personnel will also adhere to the requirements of individual mine operators when collecting samples at active and inactive mine sites. These requirements may include the use of hardhats, eye protection and steel-toed boots. It is the responsibility of the SSHO and the SSHO representing any subcontract personnel to ascertain the appropriate/required level of PPE for each mine site, communicate such findings to the field personnel, and to ensure that the field personnel are provided with the PPE in a timely manner.

PPE that will be employed for project field tasks and procedures is identified in the Activity Hazard Analysis in Appendix A. For activities undertaken during this project, personnel will incorporate the following into the standard Level D ensemble:

Item	Specifications
Exterior garments	Long pants, shirt with sleeves (no tank tops or shorts). Cold weather gear should be layered in wicking, moisture resistant layers to adjust for changing climates. Outer wear should be suitable to resist the prevailing or most limiting weather conditions.
Foot protection	Personnel will wear safety-toed footwear (ASTM F2413) when entering active and inactive mines. They also must be worn when working near drill rigs or other heavy machinery. Rubber, knee high boots should be worn for access in wet environments. High top boots with a minimum of 8" ankle support should be worn for traversing irregular and steep terrain.
Gloves	Heavy work gloves (e.g., cotton or leather). Nitrile gloves are required when handling samples, reagents, decon solutions, and calibration standards. Insulating gloves for extreme cold and heat, and cut resistant gloves when handling sharp objects.
Eye and face protection	Safety glasses with side shields. (per ANSI Z87.1). Face shield when there is a danger of scalding water splashes.
Head protection	Personnel will wear a hardhat (ANSI Z89.1) when entering active and inactive mine pits to protect against rock falls, when they are visible from the haul road, and when supervising well installations. Hard hats shall be worn with the brim facing forward

	where there is a potential for injury due to overhead, side impact or electrical hazards
Hearing protection	Earplugs or muffs with a noise reduction rating (NRR) of 25 dBA minimum, when working on or near operating equipment or machinery.
Traffic vest	Workers will wear a high-visibility traffic safety vest when working near heavy equipment and/or vehicle traffic. Vests should meet the requirements of ANSI 107, class 2.

Once on site, the SSHO and the SSHO representing any subcontractor personnel will evaluate work conditions and adjust the level of PPE as necessary to properly protect field personnel and meet the local mine requirements. When specifying a PPE ensemble, the following will be evaluated:

- The local mine requirements;
- The anticipated site hazards that were used to select the initial PPE ensemble;
- The limitations of each piece of PPE;
- Work duration;
- The effect of temperature extremes on the PPE ensemble;
- PPE maintenance, storage, decontamination, and disposal requirements;
- Inspections of PPE completed prior to, during, and after use;
- Personnel training in PPE use and the need for fit-testing;
- Procedures for donning and doffing; and
- Evaluation of the effectiveness of the current PPE program.

Adjustments to the PPE ensemble will be communicated to field personnel via amendment of this Health and Safety Plan or during the tailgate safety meeting.

9.2 LEVEL D PERSONAL PROTECTIVE EQUIPMENT

Level D protection may be used when the following conditions are met:

- Substances that pose inhalation hazards are not present above individual or combined PELs.
- Oxygen is present at a minimum concentration of 20.0 percent.
- Toxic organic compounds are not present in the air space at concentrations that exceed normal background concentrations or specified action levels requiring use of respiratory protection.
- Work functions preclude splashes, immersion in, unexpected inhalation of, or direct contact with hazardous concentrations of harmful chemicals.

Level D protective equipment shall consist, at minimum, of the following:

- Dedicated work uniforms with long pants and short-sleeve shirt.

- Steel-toed and shank leather, PVC, or rubber safety shoes or boots meeting the specifications of American National Standards Institute (ANSI) Z41.
- Safety glasses, goggles, face shield, or other approved eye protection.
- Hardhat, unless specifically stated otherwise.

The dedicated work uniforms may include chemical-resistant coveralls or standard Tyvek coveralls, or standard cotton or cotton blend work uniforms. Approved eye protection must meet the specifications of ANSI Z87.1. The use of contact lenses is discouraged, but not prohibited, during Level D operations. However, safety glasses or goggles that fit over prescription lenses or prescription safety glasses or goggles are recommended. Approved hardhats must meet the specifications of ANSI Z89.1.

Figure 9-1 Sample Protective Equipment Ensembles

9.3 PPE STORAGE

PPE must be stored properly to prevent damage or malfunction due to exposure to dust, moisture, sunlight, damaging chemicals, extreme temperatures, and impact. Potentially contaminated PPE should be stored separately from new PPE and street clothing. Field personnel should always review the manufacturer's instructions for care and maintenance of PPE. PPE storage will be provided in the field by the SSHO. However, each individual is responsible for ensuring that his or her issued PPE is protected from extremes of temperature and is stored in a manner that prevents the PPE from becoming damaged or disfigured.

10.0 DECONTAMINATION PROCEDURES

Decontamination procedures are implemented to prevent cross-contamination of samples, to control possible migration of site contaminants to clean areas, and to prevent personnel exposure to chemicals or pathogens that may contaminate clothing or protective gear. Personnel conducting field activities must decontaminate upon the completion of these activities. Equipment must also be decontaminated before it is moved. Any material that is generated by decontamination procedures will be labeled and stored until final disposal arrangements are made.

10.1 GENERAL DECONTAMINATION PROCEDURES

Decontamination procedures shall be supervised by the SSHO. The type of solution to be used for equipment decontamination is specified in the task-specific SAP and Field Sampling Plan (FSP). Personnel decontamination will be accomplished using ordinary soap and water or an alcohol based hand sanitizer. Personnel will be required to wash or sanitize their hands, and optionally their faces, before eating or drinking, unless specific procedures are in place to ensure that a drink can be taken without the possibility of contamination. Personnel may also be required to wash or sanitize their hands, and optionally their faces, before leaving the work site. Decontamination solutions will be changed daily at a minimum.

The following decontamination procedures and guidelines shall be implemented:

- Disposable protective clothing will be used when possible to eliminate the need for decontaminating clothing.
- Decontamination procedures will be designed to prevent or minimize direct contact with waste materials.
- Disposable protective clothing and contaminated material will be collected in plastic sacks and disposed of appropriately.

10.2 DECONTAMINATIOPN WASTE HANDLING AND DISPOSAL

Wastes generated as a result of site activities will be handled in accordance with applicable environmental regulations. Investigation-derived wastes and contaminated site materials will be handled and disposed of in accordance with the provisions of the FSP or client specifications. Unless specifically stated, personnel are to treat decontamination wastes as part of the investigation derived wastes.

11.0 EMERGENCY RESPONSE PLANNING

The objective of this Health and Safety Plan is to minimize exposure to chemical, biological, and physical hazards, and to prevent work-related illnesses and injuries. Emergency response planning is included as part of this plan to provide procedures for responding to emergencies that may occur. This section contains information on how to deal with emergencies. It is not the purpose of this Health and Safety Plan, however, to provide guidance for emergency response as part of field operations. Field personnel are instructed to assess emergencies and make the appropriate notification to emergency responders. **Under no circumstances are field personnel to take emergency response actions for which they are not properly trained.**

The Stantec SSHO will serve as the primary Stantec contact during any on-site emergency. The SSHO will be responsible for making the appropriate notifications, directing responses to emergencies until relieved by a qualified Emergency Medical Technician (EMT) or equivalently trained professional. As part of his or her duties, the SSHO will be required to know basic first aid emergency procedures and evacuation routes, as well as the telephone numbers of the nearest ambulance service, local hospital, poison control center, fire department, and police department. The SSHO will also be responsible for verifying the route to emergency medical facilities, and ensuring that route information is posted and available to field personnel. Emergency telephone numbers and maps showing the locations of the hospitals and emergency clinics capable of providing emergency service for field personnel are provided in Appendix E. Telephone numbers for the Poison Control Center, local Police and Sheriff's Departments, local Fire Departments, including the emergency rescue squad, the Office of Emergency Services, Stantec management, and client contacts also are included. Copies of the hospital route maps provided in Appendix E will be kept in site support vehicles and field personnel will become familiar with the routes and the travel times involved.

The SSHO shall immediately notify the Program Manager of the following:

- Any required site evacuation;
- Any fatality or injury to one or more field personnel that requires medical attention; and
- Any physical hazard creating the potential for death or permanent injury.

Vehicles that can be used to transport injured personnel from work sites will be available during working hours. A system will also be available on site for communicating with off-site personnel. On-site communication systems may include cell phones, two-way radios, or other suitable devices. Additionally, first aid supplies and potable water will be available at every site for emergency use.

Cell phones may not always be operable in remote areas. Thus, when entering remote areas field personnel will file their anticipated itinerary with the FTL. The itinerary will include where the field team expects to be, the travel route, and the expected time of return. The field team will notify the FTL upon their return. If the sampling team leaders do not hear from a field team by an agreed-upon time, the FTL will initiate search and rescue operations. In addition, the FTL will attempt to call the P_4 Program Manager daily to report on the daily activities, any health and safety issues encountered, and the expected itinerary for the next day.

Prior to the start of work, project personnel will be acquainted with established emergency response procedures and equipment. Furthermore the SSHO will be certified to render first aid and CPR prior to commencement of field activities. The buddy system will be used when working in remote areas, near significant waterways, or in active or inactive mine pits. The buddy system will not be required while collecting samples in agricultural areas when cell phone contact is available.

Accidents, safety-related incidents, and safety-related near misses will be documented and reported to the Stantec EH&S Department, HSSE ADVISOR, SSHO and P_4 and Stantec Program Managers on a daily basis at a minimum.

See Appendix K for incident reporting forms and procedures.

12.0 DOCUMENTS AND POSTINGS

The following documents, as appropriate, are required to be accessible either at the field office, and/or from an employee's home office:

The following documents are to be kept within the Project files:

- Safety meetings and risk assessment documentation – RMS2.
- Accident/Incident investigations – RMS3. (Original copies of Accident/Incident investigations must be forwarded to hsse@stantec.com , controlled copies will be maintained in project files.)

The following health and safety postings are to be displayed in a location where workers are likely to see them (e.g., a lunchroom, entry/exit trailer, administration office):

- Emergency Notification Requirements.
- Federal OSHA Job Safety and Health Protection Poster.
- A copy of the "Route to Medical Treatment" map and emergency medical contact information

Additional examples of some of the forms that may be employed for documenting compliance with the Stantec health and safety program and this Health and Safety Plan are presented in the appendices. The Stantec SSHO will maintain and update these documents. Appropriate regulatory agency personnel shall be granted access to these records if requested.

Unanticipated field conditions may occasionally require temporary modification of this Health and Safety Plan. Client notification and approval procedures will depend on field conditions and nature of the modification. Any upgrade to PPE will be reported in an updated JRA worksheet. Minor changes to the Health and Safety Plan to accommodate on-site conditions can be implemented by the SSHO upon review and approval of the Project Manager and HSSE Advisor; such changes might include minor revisions to decontamination or site control procedures. Permanent changes to this HASP must be approved by the Stantec Project Manager Project Manager as listed in Table 3-1.

APPENDIX A
ACTIVITY HAZARD ANALYSIS

Appendix A - Activity Hazard Analysis – Site Inspection/Observation

ACTIVITY HAZARD ANALYSIS					
Activity	**Hazards**	**Actions to Eliminate or Minimize Hazards**	**PPE/Other Equipment**	**Training Requirements**	**Inspection Requirements**
Biological Hazards	- Stinging/Biting Insects - Snake bites - Poisonous plants	• Pre-Briefing with to identify biological hazards • Use insect repellent containing DEET to protect against ticks and mosquitoes. Apply to clothes if it is not desired to have repellant directly on skin. • Wear long sleeve shirts and pants • Wear insect repelling (i.e., insect shield) or insect proof (i.e., Bug Baffler) clothing • Wear light colored clothing so insects are more visible • Avoid contact with vegetation • Educate yourself and be observant of poison Ivy, Oak and Sumac • Use poison ivy pre-exposure barrier cream and post-exposure cleanser to reduce urushiol-induced contact dermatitis. • Contain and decontaminate any clothing, tools or equipment that have been exposed to poison plants. Urushiol, the oil which causes adverse reaction in 85% of the population can remain active for up to 5 years. • Bring EpiPen if allergic to bee or wasp stings.	• Wear light colored clothing so that ticks are more visible • DEET • Soap and Clean Water • Zanafel or other urishiol removing substance • Mosquito netting • Workers allergic to stinging inspects must carry EpiPen and alert team members	• Review symptoms of insect-transmitted illness and disease	• Inspect self and coworkers for ticks • Inspect site and remove standing water which may be a mosquito breeding area • Keep a general awareness to the surroundings
Wildlife encounters	- Animal attack	• Be alert. Watch for fresh tracks, fresh scat, feeding and drinking sites (diggings, berry patches, rolled rocks, torn up logs, claw marks on trees, ripped open ant hills, stream banks), and dens • Avoid nesting areas / likely habitat of wildlife • Walk in groups and avoid walking outside at dawn, dusk or at night • Stay close to protective structures (i.e., cab of vehicle, support buildings, etc.) • Make noise to alert wildlife to your presence, especially when walking through dense vegetation, travelling upwind or in loud areas (in high winds, near streams) • Avoid carcasses • If you are in open country, use binoculars to scan the horizon for wildlife	• Pepper spray	• None	• Inspect surroundings regularly for signs that wildlife may be nearby.

ACTIVITY HAZARD ANALYSIS					
Activity	**Hazards**	**Actions to Eliminate or Minimize Hazards**	**PPE/Other Equipment**	**Training Requirements**	**Inspection Requirements**
High/Low Ambient Temperatures	- Hypothermia - Hyperthermia	• Monitor for heat/cold stress and provide breaks as necessary. • Provide fluids to prevent worker dehydration. • Implement work/rest regimen. • Wear clothing appropriate for weather conditions. Layer clothes in winter and use breathable, wicking materials that don't hold moisture	• Sunscreen • Sunglasses • Wide brim hat • Clothes suitable for conditions	• None	• None
Exposure to ultraviolet (UV) rays (sunburn)	- Stinging/Biting Insects - Snake bites - Poisonous plants	**Elimination/Substitution** • Avoid periods of the day when UV index is highest • Work in the shade when possible (e.g. portable shelters, beach umbrella • Take frequent breaks out of direct sunlight	• Wear long sleeve shirt and a wide-brimmed hat • Wear broad-spectrum sunblock with SPF 30 or higher	• None	• None

ACTIVITY HAZARD ANALYSIS					
Activity	**Hazards**	**Actions to Eliminate or Minimize Hazards**	**PPE/Other Equipment**	**Training Requirements**	**Inspection Requirements**
Working in congested areas near mobile equipment	- Struck by mobile equipment - Caught between moving equipment - Inhalation of diesel exhaust	**Elimination/Substitution** • Avoid areas where mobile equipment is actively operating (i.e., inspect area at break times, after hours, etc.) **Engineering Controls/Guarding** • Erect barricades, stanchions, traffic cones or other traffic control devices or stay behind them **Administrative Controls** • Review SWP 216 – Working Near Mobile Equipment and follow the safe work practices • Make eye contact with operators before approaching equipment, and verify they see you (i.e. hand wave response) • Understand and review hand signals • Use a spotter for heavy equipment operations • Ask the operator where blind spots are for each type of equipment you are working around • Never place yourself between mobile and stationary objects • Barricade heavy equipment swing radius • Obtain required permits and comply with the Manual on Uniform Traffic Control Devices (MUTCD) and other requirements. • Position yourself in clear view, upwind of the equipment at a safe distance • Wear high-vis, reflective vests when working near heavy equipment and vehicular traffic • Be alert to the direction and flow of traffic and any special instructions related to site access	• High visibility/reflective vest • Hearing protection • Safety-toed boots • Hard hat • Safety glasses	• Review of safe use practices	• Per operator

ACTIVITY HAZARD ANALYSIS					
Activity	**Hazards**	**Actions to Eliminate or Minimize Hazards**	**PPE/Other Equipment**	**Training Requirements**	**Inspection Requirements**
Manual Material Handling	- Strain/Sprain - Overexertion - Caught in/between - Struck by / against - Slip/Trip/Fall from same level - Fall from height	**Elimination/Substitution** • Avoid direct handling if possible **Engineering Controls** • Use mechanical assistance when possible (hand truck, pallet jack, carts, etc.) – 50 lb single person limit in ideal conditions **Administrative Controls** • AHA/FLRA/LMRA to plan task • Inspect prior to lift (test weight and center of gravity) • Proper ergonomic practices when lifting (item close to body, back straight, lift with legs vs back, no twisting or bending, control load and placement between knees and shoulders, etc.) • Coordinated lifting when possible – adequate manpower • Situational awareness (check load stability prior to opening doors, unbanding/unstrapping, etc.), anticipate pinch points, keep body and extremities out of line-of-fire from shifting, falling, rolling objects, know your path of travel and maintain line of sight or use spotter to guide you	• Appropriate hand protection for the items being lifted • Fall protection if exposed to heights greater than 4 feet • Mechanical assistance if necessary	• Safe lifting	• Verify load is safe to lift as stated in actions to minimize hazards
Irregular terrain	- Slip/Trip/Fall from same level - Cuts/abrasion - Strain/Sprain	**Elimination/Substitution** • Avoid steep slopes, stay away from edges of embankments. • Stay off spillway and outlet structures not designed for pedestrian access. • Do not rely on handrails as fall protection. • Avoid rip rap or other rough surfaces, if necessary use 3 points of contact while walking on rip rap. • Avoid wet or muddy surfaces. • If you must access areas with irregular surfaces, start at bottom and progress with caution. Don't climb down embankments!	• Rugged boots with slip resistant / tractive soles and ankle support. • Ice cleats for work on or adjacent to ice	• None	• Inspect for wet, icy or otherwise slick surfaces. • Inspect integrity of passive fall protection equipment (e.g. guard rails, stair rails, grating, etc.)

ACTIVITY HAZARD ANALYSIS					
Activity	**Hazards**	**Actions to Eliminate or Minimize Hazards**	**PPE/Other Equipment**	**Training Requirements**	**Inspection Requirements**
Portable hand and power tool use	- Struck by/against - Pinch points - Cut/laceration - Electric shock - Noise exposure	**Engineering Controls:** • Proper tool maintenance • Guards in place • Constant pressure switch where action is stopped when finger removed from trigger • Retractable blade for utility knife • GFCI protected circuits for all electric equipment **Administrative Controls:** • RMS2 and LMRA used for pre-task planning to anticipate hazards • Inspection prior to use • Training on proper selection and use • Proper body positioning • Safe handling of power tools (i.e., unplug before passing to another user) **Personal Protective Equipment:** • Goggles and full face shield when exposed to flying debris • Appropriate hand protection for tools used (i.e., cut resistant gloves for utility knife, vibration resistant gloves for hammer drill, etc.)	• Appropriate gloves • Hearing protection • Core PPE required • GFCI protected cord sets	• Hand and power tool use	• Inspect all tools prior to use • Safety recall inspection for power tools
Sharp or protruding objects or bump hazards	- Struck by / against - Puncture wounds - Concussion - Abrasions	• Situational awareness, observe surroundings • Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Cover or isolate sharp objects such as exposed rebar, steel plate, jagged rock, etc. with caps, high visibility tape, or other padded materials	• Hard hats • Safety glasses • Cut resistant gloves	• None	• Inspect for sharp edges and objects

ACTIVITY HAZARD ANALYSIS					
Activity	**Hazards**	**Actions to Eliminate or Minimize Hazards**	**PPE/Other Equipment**	**Training Requirements**	**Inspection Requirements**
High intensity noise/sounds from • Mobile equipment • Drilling rigs • Generators • Etc.	- Overexposure to noise	• Utilize distance to reduce noise exposure whenever practical (double the distance half the intensity) • Use hearing protection if sound levels exceed 80 dBA • Use double hearing protection if the exposure level exceeds 105 dBA	• Hearing protection	• Initial Hearing Conservation Training and Annual Refresher Training in Hearing Conservation 29 CFR 1910.95 • Baseline and annual audiograms • Training in the proper insertion and self - verification of fit for ear plugs.	• Inspect ear plugs and ear muffs prior to use. • Inspect, clean and replace hearing protection before reuse.
Motor Vehicle Operation	- Struck by/ against - Caught between - Vehicle damage - Property damage	**Elimination/Substitution** • Share rides **Engineering Controls** • Maintain vehicles in good operating condition **Administration Controls** • Pre-and post-use inspection (360 walk around) • Don't exceed vehicle capacity • Obey speed limits and other warning signs • Wear seat restraints • Watch out for other drivers and pedestrians • No mobile communications (phone/radio/iPod/etc.) • Establish eye contact in congested areas • Defensive driving practices such as: aim high in steering, get the big picture, keep your eyes scanning, leave yourself an out, make yourself seen	• Automobile/Truck • Seat restraints	• Defensive Driving	• Pre-use 360 walk around • Post-use at end of day • Regularly scheduled maintenance

ACTIVITY HAZARD ANALYSIS					
Activity	**Hazards**	**Actions to Eliminate or Minimize Hazards**	**PPE/Other Equipment**	**Training Requirements**	**Inspection Requirements**
Drilling and Test Pit Operations • Monitoring wells • Piezometers • Soil borings • Test Pits	- Overhead Utilities - Underground utilities - Slip, trip, fall from same level - Fall from height - Pinch points - Amputation - Falling objects from drill string - Struck by/ against moving equipment or machinery - Caught between tooling, equipment, samplers - Heat or cold stress	**Elimination/Substitution** • Locate wells away from overhead or underground utilities • Observe from a safe distance **Engineering Controls** • Mechanical assistance when hoisting drill components **Administrative Controls** • JSA/FLRA/LMRA to plan task • Procedures to include SWP 416 Supervision of Contracted Drilling Activities • Maintain 20 foot minimum safe approach distance from overhead electrical hazards • One call for utility location and pot hole to verify • Barricades and access control • Authorized personnel only in active drilling area • Situational awareness with respect to operations and walking surfaces • Trained operators and ground personnel • Daily inspection of drilling components • Line of fire evaluation (operating equipment, changing tooling, hoisting augers and core barrels, etc.	• Core PPE requirements, heavy duty or cut resistant gloves for handling sharp objects, additional requirements as specified by mine operator or driller • Dress for weather and conditions • Hearing protection for personnel in the active drilling area • Heavy gloves • Reamer for clearing pinned connections	• Hearing conservation when exposed >80 dBA • Competent drill crew	• Pre-use inspection of drilling rig and components

ACTIVITY HAZARD ANALYSIS					
Activity	**Hazards**	**Actions to Eliminate or Minimize Hazards**	**PPE/Other Equipment**	**Training Requirements**	**Inspection Requirements**
Site Investigation • Mobilize equipment • Digging test pits • Sampling at inactive mine sites • Use drill rig to advance drill holes • Collect soil boring samples • Collect water samples • Demobilize equipment	- Slip, trip, falls walking over rough terrain - Exposure to poisonous plants and insects - Wildlife encounters - Inclement weather - Hypothermia - Remote locations - Altitude effects - Sunburn - Strain/sprain carrying loads over irregular terrain, awkward positions and equipment demands - Flying debris, hot surfaces/burns, pinch points, vibration, and noise exposure, falling objects and elevated work from drilling or excavating operations - Dislodged rocks	• Situational awareness of surroundings at all times, watch for obstructions; holes; openings; loose debris from mine shafts, high walls, and excavation walls, moving equipment, etc. • Awareness of Overhead or Underground utilities and our clearance processes • Familiarize yourself with the AHA on Working in Congested Areas near Mobile Equipment above • Boots with adequate ankle support and fully laced • Dress in layers for warmth and moisture • Use insect repellent when necessary to control insects, tuck pants into boots and shirt into pants for tick control. Tick repellents such as permethrin may be applied to clothing before traveling to the field. Make routine tick checks throughout the day (at least every 2 hrs). Shake off clothes at the end of the day and take a hot shower while checking for ticks. • Wear PPE and have equipment on hand as identified in the FLRA and LMRA and AHAs above • Review the AHA's above • Monitor the weather reports regularly. If adverse weather is suspected, give plenty of time for personnel to climb off the dam area or other work area and return to a vehicle or to the valve house before the weather arrives • Take frequent breaks while working, stay hydrated • Wear sunscreen as necessary • Prior to start of task, discuss and follow the protocol for taking in-place samples and bucket samples • Avoid areas below drop hazards (i.e., working or walking on slopes). Warn others below if objects are dislodged, control access and properly post warnings of such hazards.	• Core PPE requirements • Specialty equipment as identified in AHAs above • 2 way communications • Extra clothes • Warm vehicle nearby	• Orientation training • HRAC • FA/CPR/AED • Qualified operators of mobile and drilling equipment	• Communication equipment • 360 on motor vehicle • Drill rig and components daily prior to use • Heavy equipment prior to use

ACTIVITY HAZARD ANALYSIS					
Activity	**Hazards**	**Actions to Eliminate or Minimize Hazards**	**PPE/Other Equipment**	**Training Requirements**	**Inspection Requirements**
Site Visit • Mobilize personnel • Visual observation of project site and surrounding area • Demobilize personnel	- Slip, trip, falls walking over rough terrain - Exposure to poisonous plants and insects - Working on or near ice and water - Wildlife encounters - Inclement weather - Hypothermia - Altitude effects - Sunburn	• Situational awareness of surroundings • Boots with adequate ankle support and fully laced • Dress in layers for warmth and moisture • Use insect repellent when necessary to control insects, tuck pants into boots and shirt into pants for tick control. Tick repellents such as permethrin may be applied to clothing before traveling to the field. Make routine tick checks throughout the day (at least every 2 hrs). Shake off clothes at the end of the day and take a hot shower while checking for ticks. • Wear PPE and have equipment on hand as identified in the FLRA and LMRA and AHAs above • Monitor the weather reports regularly. If adverse weather is suspected, give plenty of time for personnel to climb off the dam area or other work area and return to a vehicle or to the valve house before the weather arrives • Take frequent breaks while working, stay hydrated • Wear sunscreen as necessary	• Core PPE requirements • Specialty equipment as identified in AHAs above • 2 way communications • Extra clothes • Warm vehicle nearby	• Orientation training • HRAC • FA/CPR/AED	• Ice Thickness frequently • Visible survey of ice • Listen for cracks or booms • PFDs • Communication equipment • 360 on motor vehicle
Travel in Remote Areas	- Review all AHA's above - Slip, trip, falls over rough terrain - Cuts and abrasions - Weather extremes - Dehydration - Poor drinking water quality - Getting lost	• Carry ten essentials for wilderness travel (See **Table 8-2**) • Situational awareness of surroundings • Have certification in FA/CPR and ample supplies • Bring sufficient drinking water, a minimum of 1 gal per person daily • DO NOT use water in mine pits for drinking water, water purification with iodine, filters, or boiling will not remove potentially toxic metals • Dress for potential weather variations • Plan your route of travel and notify others (i.e., PM or designee) of your itineraries, including travel routes and anticipated date and time of return. make frequent contact (at least daily if possible) and have a back up plan if contact is not made. • Bring emergency shelter • If lost, don't wander which could make rescue more difficult	• Core PPE requirements • Specialty equipment as identified in AHAs above • 2-way communications • Extra clothes and provisions	• Orientation • HRAC • FA/CPR/AED	• Vehicle inspection

APPENDIX B

STANTEC HSSE DOCUMENTS

APPENDIX B.1

RMS 05 SITE INSPECTION

FORM

WORKSITE INSPECTION: FIELD (RMS5)

Stantec

Group/Business Line: ____________________ Business Center: ____________

Location: ____________________ Date: ____________

Project #: ____________________ Office Location: ____________

Purpose: To identify hazards in the field where Stantec personnel are working.

Responsibility: The Project Manager will determine how often work site inspections are required. OSEC may assist.

NOTE: for pre-use vehicle inspection, record inspection on SWP 124a – Vehicle Pre-Use Checklist.

	Status: Okay	Status: Needs Work	Status: N/A	Potential Severity Ranking (1-4)*	Repeat Item (Y or blank)	Action Required (incl. champion's name)	Date Done
HSSE Documentation							
RMS1 – hazard assessment	☐	☐	☐				
Health and Safety Plan (HASP)	☐	☐	☐				
Toolbox meeting/RMS2	☐	☐	☐				
Permits (e.g., work, confined space, hot work, etc.)	☐	☐	☐				
Clearances	☐	☐	☐				
Training requirements met	☐	☐	☐				
Safe Work Practices	☐	☐	☐				
Inspection forms (e.g., ladder, chainsaw, client-specific excavation, etc.)	☐	☐	☐				
Other: Specify: ________	☐	☐	☐				
Emergency Preparedness							
Emergency Response Plan current & available	☐	☐	☐				
Muster point	☐	☐	☐				
First aid kit stocked/available	☐	☐	☐				
Emergency eyewash available	☐	☐	☐				
First aid providers on-site	☐	☐	☐				
Fire extinguisher	☐	☐	☐				
Communication available	☐	☐	☐				
Spill response kit	☐	☐	☐				
Other: Specify: ________	☐	☐	☐				
Protective Equipment							
Hard hats	☐	☐	☐				
Safety glasses	☐	☐	☐				
Hearing protection	☐	☐	☐				
High visibility vests	☐	☐	☐				
Proper work gloves	☐	☐	☐				
Safety boots	☐	☐	☐				

Rank severity of potential hazards from 1-4, with 1 being Minor to 4 being Serious. If hazards are observed with a potential severity ranking of 4, the unsafe practice or condition must be reported as soon as possible to local leadership or supervision for investigation and corrective action.

	Status: Okay	Status: Needs Work	Status: N/A	Potential Severity Ranking (1-4)*	Repeat Item (Y or blank)	Action Required (incl. champion's name)	Date Done
18" PVC orange traffic cones	☐	☐	☐				
Road signs as required	☐	☐	☐				
Fall arrest/restraint	☐	☐	☐				
Personal floatation device	☐	☐	☐				
Other: Specify: ________	☐	☐	☐				
Tools and Equipment							
Maintenance -tools in good condition	☐	☐	☐				
Used properly	☐	☐	☐				
Appropriate for job	☐	☐	☐				
Stored and/or secured safely	☐	☐	☐				
Lockout system established	☐	☐	☐				
Clearance from panels/overhead wires	☐	☐	☐				
Guards in place	☐	☐	☐				
Other: Specify: ________	☐	☐	☐				
Chemicals							
Controlled products labeled properly	☐	☐	☐				
Stored properly	☐	☐	☐				
MSDS available	☐	☐	☐				
TDG compliance	☐	☐	☐				
Other: Specify: ________	☐	☐	☐				
Site							
Parking	☐	☐	☐				
Accessibility	☐	☐	☐				
Work area demarcated	☐	☐	☐				
Visibility	☐	☐	☐				
Slipping and tripping hazards	☐	☐	☐				
Drainage	☐	☐	☐				
Overhead hazards identified	☐	☐	☐				
Buried utilities located/marked and exposed by hand	☐	☐	☐				
Pits/excavations barricaded	☐	☐	☐				
Excavation/trench supports/slope	☐	☐	☐				
Traffic hazards controlled (including	☐	☐	☐				
Other: Specify: ________	☐	☐	☐				
Environment							
Sensitive areas identified	☐	☐	☐				

Rank severity of potential hazards from 1-4, with 1 being Minor to 4 being Serious. If hazards are observed with a potential severity ranking of 4, the unsafe practice or condition must be reported as soon as possible to local leadership or supervision for investigation and corrective action.

	Status: Okay	Status: Needs Work	Status: N/A	Potential Severity Ranking (1-4)*	Repeat Item (Y or blank)	Action Required (incl. champion's name)	Date Done
Noise levels (</= 84dBA – 8hr shift; 82dBA – 12hr shift)	☐	☐	☐				
Chemical hazards identified	☐	☐	☐				
Working near water	☐	☐	☐				
Heat/cold	☐	☐	☐				
Gas, fumes, dusts, vapors, asbestos	☐	☐	☐				
Ventilation	☐	☐	☐				
Confined space (including monitor and attendants(s))	☐	☐	☐				
Other: Specify: ______	☐	☐	☐				
General (including Buildings/Trailers)							
Exits marked and accessible	☐	☐	☐				
Stairs and walkways clean and dry	☐	☐	☐				
Handrails sturdy	☐	☐	☐				
Emergency lighting	☐	☐	☐				
General housekeeping	☐	☐	☐				
Body positioning, ergonomics (resources available on StanNet)	☐	☐	☐				
Other: Specify: ______	☐	☐	☐				

Prepared by: ______________________ ______________________ ______________
Print Name Signature Date

☐ Check if prepared by HSSE practitioner ☐ Check if prepared or accompanied by leadership (above PM) ☐ Neither HSSE nor Leadership

Approved by: ______________________ ______________________ ______________
Print Name Signature Date

Original Copy: Project Files
Copies: OSEC & Field Files & hsse@stantec.com

Rank severity of potential hazards from 1-4, with 1 being Minor to 4 being Serious. If hazards are observed with a potential severity ranking of 4, the unsafe practice or condition must be reported as soon as possible to local leadership or supervision for investigation and corrective action.

APPENDIX B.2

MEDICAL SURVEILLANCE

ASSESSMENT FORM

MEDICAL SURVEILLANCE ASSESSMENT FORM (RMS9)

This information will be used to determine routine medical screening exams for employees who perform field work and/or work in lab settings. In addition, Site Specific and Health Safety Plans (HASP) may specify project-related medical surveillance for regulated substances.

Please answer each question.

Date: ______________________________

Name: ______________________________

Phone # ______________________________

Job Title: ______________________________

Location: ____________________ Supervisor: ____________________

OSEC: ______________________________

Business Center and Line: ______________________________

Choose One:

☐ New Employee
☐ Current employee with job change
☐ Integration
☐ Annual review

The following questions assess medical screenings and surveillance requirements. If you answer "yes" to any of the questions below, please contact your HSSE representative:

	YES	NO	
Respirator:	☐	☐	Does your job require you to wear a respirator or to be certified for respirator use? If yes, how many days per year? If yes, how many days per year? ☐ **1-29 /or** ☐ **30+**
Hearing	☐	☐	Does your job require you to wear hearing protection because you: a) Work in an environment where noise levels equal or exceed an 8-hour time-weighted average of 85 decibels? b) Perform construction activities or construction management around heavy equipment on a construction project more than 50 percent of the time?
Asbestos:	☐	☐	Do you perform intrusive work with asbestos? (i.e., sampling, demolition, etc.)

Stantec

MEDICAL SURVEILLANCE ASSESSMENT FORM (RMS9)

	YES	NO	
Lead:	☐	☐	Are you currently performing construction work where you may be exposed to lead above the regulated action level or are you currently in a job that requires you to be in a medical surveillance program for lead. (i.e. removal of lead based paint or other demolition activities).
Radiation:	☐	☐	Are you classified as a radiation worker (US/Canada) or a Nuclear Energy Worker (Canada)?
DOT/Commercial Driver:	☐	☐	Do you drive a truck with a gross vehicle weight rating of 10,000 pounds or more during company tasks or activities?
Biohazard:	☐	☐	Does your job require work with blood borne pathogens?
Remediation:	☐	☐	Do you perform: • Heavy remediation construction activities • Field construction sampling or supervision activities at hazardous waste sites, or • HAZWASTE treatment, storage, or disposal (TSD) facilities which could expose you to hazardous substances above permissible exposure levels? (i.e. exclusion zone). If yes, how many days per year? ☐ **1 -29 /or** ☐ **30+**
Field and Lab:	☐	☐	Answer yes if you do ANY of the following: a) Work at HAZWOPER (US)/Hazardous Waste Emergency Response (Canada) sites 1 to 29 days per year b) Perform waste disposal activities c) Perform non-HAZWOPER sampling of regulated materials d) Work in a chemistry laboratory 30 or more days per year e) Work on a pilot plant project 30 or more days per year f) Conduct bench scale operations 30 or more days per year
Other:	☐	☐	Site/Project specific biological monitoring or toxicological screening as specified by the project-specific health and safety plan.

Distribution List:

☐ Supervisor
☐ OSEC

Employee Signature: ______________________ Date: ______________

Supervisor Signature ______________________ Date ______________

APPENDIX B.3

MANAGEMENT OF

CHANGE FORM

MANAGEMENT OF CHANGE (MOC) FORM – RMS11

Management of Change

All temporary and permanent changes to the project* personnel, systems, procedures, equipment, products, materials, or substances will be evaluated and managed to confirm that HSSE risks arising from these changes remain at an acceptable level. **Changes to the HSSE Program, SWPs, or the Occupational Health and Safety Management System as applied to a geography, region, or discipline must be approved by an HSSE Director or above.**

Type of Change:	☐ Practice	☐ Personnel/Job	☐ Systems/Process
	☐ Procedure	☐ Equipment	☐ Products/Materials/Substances
	☐ Regulatory		
Nature of Change:	☐ Permanent	☐ Temporary	Dates Valid:

Description of Change:		
Reason for Change:		

Risk Assessment/Work Plan

Critical Changes	Identified Hazard	Potential Risk Level	Controls to be put in place and/or actions to be completed prior to change	Mitigated Risk Level	Responsible Person	Change Date

MOC Owner:		
MOC Review:		
MOC Approval*:		

*Please note: MOC Approval must come from a sufficient level of authority to authorize the change. A project is defined as a temporary endeavour undertaken to create a unique product, service, or result.

APPENDIX B.4

STANDARD WORK PRACTICES

(ELECTRONIC COPY ONLY)

APPENDIX C

MSDS

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Alconox Detergent
Catalog Number: 2088000

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00901
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Surfactants
Hazard: No effects anticipated.
Date of MSDS Preparation:
Day: 11
Month: December
Year: 2001

2. COMPOSITION / INFORMATION ON INGREDIENTS

Alkyl aryl sulphonates, lauryl alcohol sulfates, phosphates and carbonates
CAS No.: Not applicable
TSCA CAS Number: Not applicable
Percent Range: 100.0
Percent Range Units: weight / weight
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: No effects anticipated.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: White powder
Odor: None

HMIS:
Health: 0
Flammability: 0
Reactivity: 0

Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 0
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: No effects are anticipated
Skin Contact: No effects are anticipated
Skin Absorption: No effects anticipated
Target Organs: Not applicable
Ingestion: None reported
Target Organs: None reported
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: None reported
Chronic Effects: None reported
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: None reported
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Flush eyes with water.
Skin Contact (First Aid): Wash skin with plenty of water.
Ingestion (First Aid): Give large quantities of water. Call physician immediately.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: Material will not burn.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined
Hazardous Combustion Products: None reported
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:

Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Stop spilled material from being released to the environment.
Clean-up Technique: Sweep up material. Place material in a plastic bag. Mark bag 'Non-hazardous trash', and dispose of as normal refuse. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: None

7. HANDLING / STORAGE

Handling: Avoid contact with eyes Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep container tightly closed when not in use.
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: Not applicable
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: White powder
Physical State: Solid
Molecular Weight: Not applicable
Odor: None
pH: Not determined
Vapor Pressure: Not applicable
Vapor Density (air = 1): Not applicable
Boiling Point: Not applicable
Melting Point: Not determined
Specific Gravity (water = 1): Not determined
Evaporation Rate (water = 1): Not applicable
Volatile Organic Compounds Content: Not applicable
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Soluble
Acid: Not determined
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Excess moisture
Reactivity / Incompatibility: None reported
Hazardous Decomposition: Heating to decomposition releases toxic fumes of carbon monoxide and carbon dioxide.
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported
Mutation Data: None reported
Reproductive Effects Data: None reported
Ingredient Toxicological Data: --
No toxicological data available for the ingredients of this product.

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: --
No ecological data available for the ingredients of this product.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: None
Special Instructions (Disposal): Place material in a plastic bag. Mark bag 'Non-hazardous trash', and dispose of as normal refuse.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA

I.M.O.:

I.M.O. Proper Shipping Name: Not Currently Regulated

--

I.M.O. Hazard Class: NA

I.M.O. Subsidiary Risk: NA

I.M.O. ID Number: NA

I.M.O. Packing Group: NA

Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit Hazard Class: 9 UN Number 3316.

15. REGULATORY INFORMATION

U.S. Federal Regulations:

O.S.H.A.: This product does not meet the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)

E.P.A.:

S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): This product is not hazardous under 29 CFR.1910.1200 and therefore is not covered by Title III under SARA.

S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.

--

302 (EHS) TPQ (40 CFR 355): Not applicable

304 CERCLA RQ (40 CFR 302.4): Not applicable

304 EHS RQ (40 CFR 355): Not applicable

Clean Water Act (40 CFR 116.4): Not applicable

RCRA: Contains no RCRA regulated substances.

C.P.S.C.: Not applicable

State Regulations:

California Prop. 65: No Prop. 65 listed chemicals are present in this product.

Identification of Prop. 65 Ingredient(s): None

Trade Secret Registry: Not applicable

National Inventories:

U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).

TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Surfactant

References: Vendor Information. Technical Judgment.

Revision Summary: Updates in Section(s) 14,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

GFS CHEMICALS, INC.
P.O. Box 245 Powell, OH 43065
740-881-5501(Tel.) 740-881-5989(Fax)
1-800-424-9300(Chemtrec 24Hr. Info.)

MATERIAL SAFETY DATA SHEET

2174

CONDUCTIVITY STANDARD SOLUTION

CHEMICAL NAME & SYNONYMS	DOT CLASS	SARA TITLE 313
Conductivity Standard Solution	NR	No
Potassium Chloride, Solution	**TSCA listed** - Yes	

FORMULA	REPORTABLE QUANTITY	F.W.	CAS#
KCl <5% - Not a hazardous material.	N/A	74.55	7447-40-7
H_2O >95%	N/A	18.02	7732-18-5

PHYSICAL DATA
Boiling point 100°C; Density 1.0; Conductivity @25°C 1,413 uS/cm (uMHO). Completely miscible with water.

APPEARANCE & ODOR
Clear, colorless solution. Odorless.

REACTIVITY & CONDITIONS TO AVOID
None.

FIRE HAZARDS
None.

EXTINGUISHER	FLASHPOINT	LEL	UEL
Fight surrounding fire.	N/A	N/A	N/A

HEALTH HAZARDS
Toxicity of this solution is very low (this is a very weak salt solution). Any salt solution may be irritating to eyes and mucous membranes. LD/TD: not found. OSHA PEL/ACGIH TLV not established. Not considered to be a carcinogen.

SPECIAL PRECAUTIONS
Always use good laboratory practices.

FIRST AID
Wash with water. If irritation develops, get medical attention.

SPILLS & LEAKS
Wash up with water. Disposal to sanitary drain.

CATALOG #	PREPARED BY	DATE
2174	MDM	April 1, 2004

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Ferrous Iron Reagent
Catalog Number: 2514025

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00024
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: May cause irritation.
Date of MSDS Preparation:
Day: 05
Month: October
Year: 2007

2. COMPOSITION / INFORMATION ON INGREDIENTS

1, 10-Phenanthroline
CAS No.: 5144-89-8
TSCA CAS Number: 66-71-7
Percent Range: 1.0 - 10.0
Percent Range Units: weight / weight
LD50: Oral Rat LD_{50} = 132 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation.

Sodium Bicarbonate
CAS No.: 144-55-8
TSCA CAS Number: 144-55-8
Percent Range: 90.0 - 100.0
Percent Range Units: weight / weight
LD50: Oral rat LD50 = 4220 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: White powder
Odor: Not determined
MAY CAUSE EYE, SKIN AND RESPIRATORY TRACT IRRITATION

HMIS:
Health: 1
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 1
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation
Skin Absorption: None reported
Target Organs: None reported
Ingestion: Very large doses may cause: abdominal pain gastrointestinal disturbances alkalosis which causes abnormally high alkali reserve of the blood and other body fluids hypotension
Target Organs: None reported
Inhalation: May cause: respiratory tract irritation
Target Organs: None reported
Medical Conditions Aggravated: Pre-existing: Kidney conditions
Chronic Effects: None reported
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: None reported
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water. Call physician if irritation develops.
Ingestion (First Aid): Give large quantities of water. Call physician immediately.
Inhalation: Remove to fresh air.

5. FIRE FIGHTING MEASURES

Flammable Properties: Does not burn, but may melt in a fire, releasing toxic fumes.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not applicable

Hazardous Combustion Products: Toxic fumes of: sodium monoxide nitrogen oxides. carbon monoxide, carbon dioxide.
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Water. Carbon dioxide Dry chemical.
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

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6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Stop spilled material from being released to the environment.
Clean-up Technique: Scoop up spilled material into a large beaker and dissolve with water. Flush the spilled material to the drain with a large excess of water. Decontaminate the area of the spill with a weak acid solution.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: None

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7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin Do not breathe dust. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep container tightly closed when not in use. Protect from: moisture oxidizers
Flammability Class: Not applicable

---

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin Do not breathe: dust Wash thoroughly after handling. Keep away from: oxidizers
TLV: Not established
PEL: Not established

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9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: White powder
Physical State: Solid
Molecular Weight: Not applicable
Odor: Not determined
pH: Not determined
Vapor Pressure: Not applicable
Vapor Density (air = 1): Not applicable

Boiling Point: Not applicable
Melting Point: Not determined
Specific Gravity (water = 1): 2.10
Evaporation Rate (water = 1): Not applicable
Volatile Organic Compounds Content: Not applicable
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Slightly soluble
Acid: Slightly soluble
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Excess moisture Heating to decomposition.
Reactivity / Incompatibility: Incompatible with: oxidizers
Hazardous Decomposition: Toxic fumes of: nitrogen oxides sodium oxides carbon monoxide carbon dioxide
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: Sodium Bicarbonate: Eye - rabbit - 100 mg/30 seconds - MILD; Skin - Human - 30 mg/3 days intermittent - MILD
Mutation Data: None reported
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Sodium Bicarbonate: Oral rat LD_{50} = 4220 mg/kg; 1, 10-Phenanthroline: Oral rat LD_{50} = 132 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: --
No ecological data available for the ingredients of this product.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: None
Special Instructions (Disposal): Dilute material with excess water making a weaker than 5% solution. Open cold water tap completely, slowly pour the material to the drain.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA
I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit Hazard Class: 9 UN Number 3316. ALSO NOTE: If the National Competent Authority declares this product an environmental hazard by Special Provision 909 (IMDG) and Special Provision A97 (IATA) the classification may be UN3077 or UN3082.

15. REGULATORY INFORMATION

U.S. Federal Regulations:
O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)
E.P.A.:
S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard
S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.
--
302 (EHS) TPQ (40 CFR 355): Not applicable
304 CERCLA RQ (40 CFR 302.4): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
Clean Water Act (40 CFR 116.4): Not applicable
RCRA: Contains no RCRA regulated substances.
C.P.S.C.: Not applicable
State Regulations:
California Prop. 65: No Prop. 65 listed chemicals are present in this product.
Identification of Prop. 65 Ingredient(s): None
California Perchlorate Rule CCR Title 22 Chap 33:
Trade Secret Registry: Not applicable
National Inventories:
U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).
TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Iron determination
References: TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). In-house information. Technical Judgment. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991.
Revision Summary: Updates in Section(s) 14,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

Procter & Gamble
Fabric and Home Care Division
Ivorydale Technical Center
5299 Spring Grove Avenue
Cincinnati, OH 45217-1087

MATERIAL SAFETY DATA SHEET

MSDS #: LDL 0001 — Issue Date: 09/28/00
Supersedes: LDL9901 — Issue Date: 02/17/99

SECTION I - CHEMICAL PRODUCT

Identity: **Liquid Hand Dishwashing Detergents**

Brands:

DAWN (All Variations)

IVORY (All Variations)

JOY (All Variations)

Hazard Rating:			
	Health:	2	4=EXTREME
	Flammability:	1	3=HIGH
	Reactivity:	0	2= MODERATE
			1=SLIGHT

Emergency Telephone Number: 24hr P&G Operator:

DAWN **-** 1-800-725-3296 (DAWN)

IVORY 1-800-253-2753 (IVORY)

JOY **-** 1-800-436-1569 (JOY)

or call Local Poison Control Center or your physician

SECTION II - COMPOSITION AND INGREDIENTS

Ingredients/Chemical Name: Cleaning and sudsing agents (anionic and nonionic surfactants), dispensing aid (ethyl alcohol), water, stabilizing agents, colorant and perfume.

Dawn and Joy Antibacterial Hand Soaps also contain the antibacterial active Triclosan.
Dawn Hand Care product contains a protease enzyme.

Hazardous Ingredients as defined by OSHA, 29 CFR 1910.1200.

Chemical Name	Common Name	CAS No.	Recommended Limits	Composition Range	LD50/LC50
Ethyl alcohol	Ethanol	64-17-5	ACGIH TLV: 1880 mg/m^3	5-10%	N/A
Subtilisin	Protease	9014-01-1	NIIOSH STEL 0.00006 mg/m^3	<0.01%	N/A

SECTION III - HAZARDS IDENTIFICATION

Health Hazards (Acute and Chronic):

Ingestions:	Ingestion may cause transient gastrointestinal irritation.
Eye Contact:	May cause mild, transient irritation.
Skin:	Transient irritation with prolonged exposure to concentrated material.

Signs and Symptoms of Exposure:

Ingestion:	May result in nausea, vomiting, and/or diarrhea.
Eye Contact:	May cause stinging, tearing, itching, swelling, and/or redness.
Skin:	Prolonged contact with concentrated material may be drying or transiently irritating to skin.

SECTION IV - FIRST AID INFORMATION

Emergency and First Aid Procedures:

Ingestion:	Drink 1 or 2 glasses of water.
Eye Contact:	Flush thoroughly with water for 15 minutes.
Skin:	If prolonged contact occurs, rinse thoroughly with water. If spilled on clothing, change clothes. If symptoms persist or recur, seek medical attention.

Other: Consumer product package has a voluntary avoid accidents statement.

SECTION V - FIRE FIGHTING INFORMATION

Flash Point (Method Used): 105-130°F. Pensky-Martens (Closed cup)

Explosive Limits: *LEL:* N/A *UEL*: N/A

Extinguishing Media: CO_2, water or dry chemical.

Special Fire Fighting Procedures: None. Although this product has a flash point below 200°F (closed cup), it is an aqueous solution containing ethyl alcohol which does not sustain combustion.

Unusual Fire Hazards: None

Stability *Unstable*:
Stable: X

Conditions to Avoid: None known

Incompatibility (Materials to Avoid): None known

Hazardous Decomposition/By Products: None known

Hazardous Polymerization: *May Occur*:
Will Not Occur: X

Conditions to Avoid: None known

SECTION VI - ACCIDENTAL RELEASE MEASURES

Personal Precautions: None

Environmental Precautions: DISPOSAL IS TO BE PERFORMED IN COMPLIANCE WITH ALL FEDERAL, STATE AND LOCAL REGULATIONS. **Ultra Dawn, Ultra Joy and Ultra Ivory undiluted waste products are considered RCRA Ignitable.**

Solutions of the Ultra Dawn, Ultra Ivory or Ultra Joy liquid hand dishwashing detergents, diluted in the course of use, may be allowed to be flushed down sewer. First check with your local water treatment plant. Recycling is recommended for undiluted scrap product. Do not landfill.

Steps To Be Taken in Case Material is Released or Spilled: Prevent spills from reaching a waterway. Sorbents may be used. Read "Waste Disposal Method" below for further information.

SECTION VII - HANDLING AND STORAGE

Precautions To Be Taken in Handling and Storing: No unusual precautions necessary.

Other Precautions: None known

SECTION VIII - EXPOSURE CONTROLS, PERSONAL PROTECTION

Respiratory Protection (Specify Type): None required with normal use.

Ventilation *Local Exhaust*: None required with normal consumer use. *Special*: None

Mechanical (General): Normal/general dilution ventilation is acceptable. *Other*: None

Eye Protection: None required with normal consumer use.

Industrial Setting: For splash protection, use chemical goggles. Eye Wash fountain is desirable.

Protective Gloves: None required with normal use.

Industrial Setting: Protective gloves (rubber, neoprene) should be used for prolonged direct contact.

Other Protective Equipment: None required with normal use.

SECTION IX - PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point °F: Not known

Vapor Pressure (mm Hg): N/A

Vapor Density (Air=1): N/A

Odor Threshold: N/A

Coefficient of Water/Oil Distribution: N/A

Scooped Density: N/A

Appearance and Odor: Purple, Blue, Green, Yellow, Pink or Orange liquids. All products are perfumed.

Specific Gravity (H_2O=1): ca. 1

Percent Volatile by Volume (%): ~60-65%

Evaporation Rate (nBuOAc=1): Unknown

Freezing Point: ~ 30 F

pH (1% solution): ~ 8

Solubility in Water: Completely

Reserve Alkalinity: N/A

SECTION X - STABILITY AND REACTIVITY

Possible Hazardous Reactions/Conditions: None known

Conditions to Avoid: None

Materials to Avoid: None

Hazardous Decomposition Products: None known

Other Recommendations: None

SECTION XI - TOXICOLOGICAL INFORMATION

LD50 (rats oral): approx 12 mL/kg
ED50 approx 2.3 mL/kg
Liquid hand dishwashing detergents have a relatively low order of toxicity. They may be irritating, but they are not expected to be corrosive. They are expected to be emetic.

SECTION XII - ECOLOGICAL INFORMATION
All surfactants are readily biodegradable. These products are safe for septic tanks.

SECTION XIII - DISPOSAL CONSIDERATIONS
Waste Disposal Method: DISPOSAL IS TO BE PERFORMED IN COMPLIANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS. RCRA hazardous under the classification "Ignitable." RCRA provides an exemption for household waste. Household product is safe for disposal down the drain during use or in the trash. *Industrial Setting*: Solutions of diluted detergent in the course of use, may be allowed to be flushed down sewer. First check with your local water treatment plant. Recycling is recommended for undiluted scrap product. **Hazardous waste incineration is necessary for the Ultra versions of these products if disposal is ultimately warranted**. Do not landfill.

SECTION XIV - TRANSPORT INFORMATION
Small household containers of Dawn, Joy and Ivory are not DOT regulated.

SECTION XV - ADDITIONAL REGULATORY INFORMATION
All components are listed on the US TSCA Inventory. No components are affected by Significant New Use Rules (SNURs) under TSCA §5. No components of Dawn, Ivory or Joy are subject to California Proposition 65 labeling. All ingredients are CEPA approved for import to Canada by Procter & Gamble only. This product has been classified with Hazard Criteria of the Canadian Control Products Regulation (CPR) and this MSDS contains all information required by the Canadian Products Regulation.

SECTION XVI - OTHER INFORMATION
*N/A. - Not Applicable   *N/K. - Not Known The submission of this MSDS may be required by law, but this is not an assertion that the substance is hazardous when used in accordance with proper safety practices and normal handling procedures. Data supplied is for use only in connection with occupational safety and health. The information contained herein has been compiled from sources considered by Procter & Gamble to be dependable and is accurate to the best of the Company's knowledge. The information relates to the specific material designated herein, and does not relate to the use in combination with any other material or any other process. Procter & Gamble assumed no responsibility for injury to the recipient or third persons, for any damage to any property resulting from misuse of the controlled product.

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Nitric Acid
Catalog Number: 15249

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00222
Chemical Name: Nitric acid
CAS No.: 7697-37-2
Chemical Formula: HNO_3
Chemical Family: Inorganic Acid
Hazard: Causes severe burns. Oxidizer.
Date of MSDS Preparation:
Day: 19
Month: March
Year: 2007

2. COMPOSITION / INFORMATION ON INGREDIENTS

Nitric Acid
CAS No.: 7697-37-2
TSCA CAS Number: 7697-37-2
Percent Range: 65.0 - 75.0
Percent Range Units: weight / weight
LD50: Oral human LDLo = 430 mg/kg.
LC50: Inhalation rat LC_{50} = 625 ppm/4hours.
TLV: 2 ppm
PEL: 2 ppm
Hazard: Causes severe burns. Oxidizer.

Demineralized Water
CAS No.: 7732-18-5
TSCA CAS Number: 7732-18-5
Percent Range: 25.0 - 35.0
Percent Range Units: weight / weight
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: No effects anticipated.

3. HAZARDS IDENTIFICATION

Emergency Overview:

Appearance: Faint yellow to colorless

Odor: Suffocating

MAY BE FATAL IF SWALLOWED OR INHALED CAUSES SEVERE BURNS

STRONG OXIDIZER: CONTACT WITH OTHER MATERIAL MAY BE EXPLOSIVE

HMIS:

Health: 3

Flammability: 1

Reactivity: 1

Protective Equipment: X - See protective equipment, Section 8.

NFPA:

Health: 3

Flammability: 0

Reactivity: 0

Symbol: oxy

Potential Health Effects:

Eye Contact: Causes severe burns

Skin Contact: Causes severe burns

Skin Absorption: None reported

Target Organs: None reported

Ingestion: Causes: severe burns

Target Organs: None reported

Inhalation: Causes: severe burns May cause: bronchitis pneumonitis teeth erosion

Target Organs: None reported

Medical Conditions Aggravated: Pre-existing: Eye conditions Respiratory conditions Skin conditions

Chronic Effects: Chronic overexposure may cause erosion of the teeth

Cancer / Reproductive Toxicity Information:

O.S.H.A. Listed: No

IARC Listed: No

NTP Listed: No

Additional Cancer / Reproductive Toxicity Information: None reported

Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.

Skin Contact (First Aid): Wash skin with plenty of water for 15 minutes. Remove contaminated clothing. Call physician immediately.

Ingestion (First Aid): Do not induce vomiting. Give 1-2 glasses of water. Never give anything by mouth to an unconscious person. Call physician immediately.

Inhalation: Remove to fresh air. Give artificial respiration if necessary. Call physician.

5. FIRE FIGHTING MEASURES

Flammable Properties: Not Flammable, but reacts with most metals to form flammable hydrogen gas. Strong oxidizer. Contact with combustible materials may cause a fire or explosion.

Flash Point: Not applicable

Method: Not applicable

Flammability Limits:

Lower Explosion Limits: Not applicable

Upper Explosion Limits: Not applicable
Autoignition Temperature: Not applicable
Hazardous Combustion Products: Toxic fumes of: nitrogen oxides.
Fire / Explosion Hazards: Contact with metals gives off hydrogen gas which is flammable May react violently with: combustible materials
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions Water spray to cool containers
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Remove all combustible material from spill area. Absorb spilled liquid with non-reactive sorbent material. Stop spilled material from being released to the environment. Dike large spills to keep spilled material from entering sewage and drainage systems or bodies of water.
Clean-up Technique: Cover spilled material with an alkali, such as soda ash or sodium bicarbonate. Scoop up slurry into a large beaker. Dilute with a large excess of water. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Flush reacted material to the drain with a large excess of water. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate local area (15 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Product is regulated as RCRA hazardous waste. Product is regulated as a hazardous water pollutant.
304 EHS RQ (40 CFR 355): Nitric Acid 1000 lbs.
D.O.T. Emergency Response Guide Number: 157

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin clothing Do not breathe mist or vapors. Use with adequate ventilation. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Store in a cool, dry place. Keep away from: combustible materials heat metals organic material
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Have a safety shower nearby. Use a fume hood to avoid exposure to dust, mist or vapor. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: neoprene latex gloves
Inhalation Protection: laboratory fume hood
Precautionary Measures: Avoid contact with: eyes skin clothing Do not breathe: mist/vapor Keep away from: alkalies metals organic materials other combustible materials oxidizable materials Wash thoroughly after handling.
TLV: 2 ppm
PEL: 2 ppm

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Faint yellow to colorless
Physical State: Liquid
Molecular Weight: 63.006
Odor: Suffocating
pH: <0.5
Vapor Pressure: 62 mm Hg @ 20°C
Vapor Density (air = 1): 2 - 3
Boiling Point: 122°C (251.6°F)
Melting Point: -34°C (-29.2°F)
Specific Gravity (water = 1): 1.41
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: None
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Miscible
Acid: Miscible
Other: Not determined
Metal Corrosivity:
Steel: Corrosive
Aluminum: Corrosive

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Excess moisture
Reactivity / Incompatibility: May react violently in contact with: acids alkalies carbides hydrogen sulfide metals turpentine May explode in contact with: combustible materials
Hazardous Decomposition: Toxic fumes of: nitrogen oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: Oral human LDLo = 430 mg/kg.
LC50: Inhalation rat LC_{50} = 625 ppm/4hours.
Dermal Toxicity Data: None reported.
Skin and Eye Irritation Data: None reported.
Mutation Data: None reported.
Reproductive Effects Data: Oral rat TDLo = 2345 mg/kg: biochemical and metabolic effects on newborn.
Ingredient Toxicological Data: Not applicable

12. ECOLOGICAL INFORMATION

Product Ecological Information: Shore crab LC50 = 180 mg/l/48H; Cockle LC50 = 330 - 1000 mg/l/48H; Starfish LC50 = 100-300 mg/l/48H

Ingredient Ecological Information: --
Not applicable

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: D002

Special Instructions (Disposal): Work in an approved fume hood. Working in a large container, cautiously add small portions of the material to cold water with agitation. Do not breathe the fumes. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Open cold water tap completely, slowly pour the reacted material to the drain.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash. Rinsate from empty containers may contain sufficient product to require disposal as hazardous waste.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Nitric Acid (70%)
DOT Hazard Class: 8
DOT Subsidiary Risk: NA
DOT ID Number: UN2031
DOT Packing Group: II
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Nitric Acid (70%)
ICAO Hazard Class: 8
ICAO Subsidiary Risk: NA
ICAO ID Number: UN2031
ICAO Packing Group: II
I.M.O.:
I.M.O. Proper Shipping Name: Nitric Acid (70%)
I.M.O. Hazard Class: 8
I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: UN2031
I.M.O. Packing Group: II
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit Hazard Class: 9 UN Number 3316.

15. REGULATORY INFORMATION

U.S. Federal Regulations:
O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)
E.P.A.:
S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard Delayed (Chronic) Health Hazard Fire Hazard
S.A.R.A. Title III Section 313 (40 CFR 372): This product contains a chemical(s) subject to the reporting requirements of Section 313 of Title III of SARA.
Nitric Acid
302 (EHS) TPQ (40 CFR 355): Nitric acid: 1000 lbs.
304 CERCLA RQ (40 CFR 302.4): Nitric acid: 1000 lbs.
304 EHS RQ (40 CFR 355): Nitric Acid 1000 lbs.
Clean Water Act (40 CFR 116.4): Nitric acid - RQ 1000 lbs.
RCRA: Contains RCRA regulated substances. See Section 13, EPA Waste ID Number.

C.P.S.C.: The label for this product bears the signal word "POISON" because the concentration of Nitric Acid in the product is greater than/equal to 5%.

State Regulations:

California Prop. 65: No Prop. 65 listed chemicals are present in this product.

Identification of Prop. 65 Ingredient(s): None

California Perchlorate Rule CCR Title 22 Chap 33:

Trade Secret Registry: Not applicable

National Inventories:

U.S. Inventory Status: TSCA Listed: Yes

TSCA CAS Number: 7697-37-2

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16. OTHER INFORMATION

Intended Use: Laboratory reagent

References: Vendor Information. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. The Merck Index, 11th Ed. Rahway, New Jersey: Merck and Co., Inc., 1989. NIOSH Registry of Toxic Effects of Chemical Substances, 1985-86. Cincinnati: U.S. Department of Health and Human Services, April, 1987. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor).

Revision Summary: Updates in Section(s) 14,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: NitriVer ® 3 Nitrite Reagent
Catalog Number: 2107169

Hach Company	Emergency Telephone Numbers:
P.O.Box 389	(Medical and Transportation)
Loveland, CO USA 80539	(303) 623-5716 24 Hour Service
(970) 669-3050	(515)232-2533 8am - 4pm CST

MSDS Number: M00055
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: Causes eye burns.
Date of MSDS Preparation:
Day: 24
Month: March
Year: 2007

2. COMPOSITION / INFORMATION ON INGREDIENTS

Chromatropic Acid, Disodium salt
CAS No.: 129-96-4
TSCA CAS Number: 129-96-4
Percent Range: 1.0 - 5.0
Percent Range Units: weight / weight
LD50: Oral rat LD50 > 5000 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation.

Sodium Sulfanilate
CAS No.: 515-74-2
TSCA CAS Number: 515-74-2
Percent Range: 5.0 - 15.0
Percent Range Units: weight / weight
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: Toxic properties unknown. May cause irritation.

Potassium Pyrosulfate
CAS No.: 7790-62-7
TSCA CAS Number: 7790-62-7

Percent Range: 1.0 - 10.0
Percent Range Units: weight / weight
LD50: Oral rat LD50 = 2340 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: Causes eye burns.

<u>Potassium Phosphate, Monobasic</u>
CAS No.: 7778-77-0
TSCA CAS Number: 7778-77-0
Percent Range: 75.0 - 85.0
Percent Range Units: weight / weight
LD50: Oral rat LD50 = 7100 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation.

<u>1,2-Cyclohexanediaminetetraacetic Acid Trisodium Salt</u>
CAS No.: 36679-96-6
TSCA CAS Number: 36679-96-6
Percent Range: 1.0 - 5.0
Percent Range Units: weight / weight
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: Toxic properties unknown. May cause irritation.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: White powder
Odor: Not determined
CAUSES EYE BURNS MAY CAUSE SKIN AND RESPIRATORY TRACT IRRITATION

HMIS:
Health: 3
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 2
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: Causes eye burns.
Skin Contact: May cause irritiation
Skin Absorption: None reported
Target Organs: None reported

Ingestion: May cause: irritation of the mouth and esophagus Very large doses may cause: gastrointestinal disturbances cardiac depression kidney damage
Target Organs: Heart Kidneys
Inhalation: May cause: irritation of nose and throat
Target Organs: None reported
Medical Conditions Aggravated: Pre-existing: Eye conditions Kidney conditions Central nervous system diseases
Chronic Effects: None reported
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: None reported
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water. Call physician if irritation develops.
Ingestion (First Aid): Do not induce vomiting. Give 1-2 glasses of water. Call physician immediately. Never give anything by mouth to an unconscious person.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. Call physician.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, this product decomposes to form toxic gases.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not applicable
Hazardous Combustion Products: Toxic fumes of: phosphorus oxides carbon monoxide, carbon dioxide.
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Stop spilled material from being released to the environment.
Clean-up Technique: Scoop up spilled material into a large beaker and dissolve with water. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Flush the spilled material to the drain with a large excess of water.
Evacuation Procedure: Evacuate local area (15 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled.

Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: None

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin Do not breathe dust. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Protect from: light heat moisture
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves lab coat
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin Do not breathe: dust Wash thoroughly after handling. Protect from: light heat moisture
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: White powder
Physical State: Solid
Molecular Weight: Not applicable
Odor: Not determined
pH: of 5% solution = 3.2
Vapor Pressure: Not applicable
Vapor Density (air = 1): Not applicable
Boiling Point: Not applicable
Melting Point: 224°C (435°F)
Specific Gravity (water = 1): 3.12
Evaporation Rate (water = 1): Not applicable
Volatile Organic Compounds Content: Not applicable
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Soluble
Acid: Not determined
Other: Not determined
Metal Corrosivity:
Steel: 0.057 in/yr
Aluminum: 0.00 in/yr

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Excess moisture Extreme temperatures
Reactivity / Incompatibility: None reported
Hazardous Decomposition: Toxic fumes of: phosphorus oxides carbon dioxide carbon monoxide
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported
Mutation Data: None reported
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Chromatropic Acid: Oral rat LD50: >5000 mg/kg, Potassium Phosphate Monobasic: Oral rat LD50 = 7100 mg/kg, Potassium Pyrosulfate: Oral rat LD50 = 2340 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: --
No ecological data available for the ingredients of this product.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: None
Special Instructions (Disposal): Dilute material with excess water making a weaker than 5% solution. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Open cold water tap completely, slowly pour the reacted material to the drain.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA
I.M.O. Subsidiary Risk: NA

I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit Hazard Class: 9 UN Number 3316.

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15. REGULATORY INFORMATION

U.S. Federal Regulations:
O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)
E.P.A.:
S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard
S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.
--
302 (EHS) TPQ (40 CFR 355): Not applicable
304 CERCLA RQ (40 CFR 302.4): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
Clean Water Act (40 CFR 116.4): Not applicable
RCRA: Contains no RCRA regulated substances.
C.P.S.C.: Not applicable
State Regulations:
California Prop. 65: No Prop. 65 listed chemicals are present in this product.
Identification of Prop. 65 Ingredient(s): None
California Perchlorate Rule CCR Title 22 Chap 33:
Trade Secret Registry: Not applicable
National Inventories:
U.S. Inventory Status: This product contains a chemical(s) exempt from the TSCA 8(b) Inventory due to a Low Volume Exemption held by Hach Company.
TSCA CAS Number: Not applicable
1,2-Cyclohexanediaminetetraacetic Acid Trisodium Salt. This chemical may only be used as a chelating reagent for chemical reactions.

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16. OTHER INFORMATION

Intended Use: Determination of nitrite
References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. In-house information. Technical Judgment. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992.
Revision Summary: Updates in Section(s) 14,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

Material Safety Data Sheet

Nitrogen

Section 1. Chemical product and company identification

Product name	:	Nitrogen
Supplier	:	AIRGAS INC., on behalf of its subsidiaries 259 North Radnor-Chester Road Suite 100 Radnor, PA 19087-5283 1-610-687-5253
Product use	:	Synthetic/Analytical chemistry. Liquid – cryogenic coolant.
Synonym	:	nitrogen (dot); nitrogen gas; Nitrogen NF, LIN, Cryogenic Liquid Nitrogen, Liquid Nitrogen
MSDS #	:	001040
Date of Preparation/Revision	:	**2/13/2009.**
In case of emergency	:	1-866-734-3438

Section 2. Hazards identification

Physical state	:	Gas. [NORMALLY A COLORLESS GAS: MAY BE A CLEAR COLORLESS LIQUID AT LOW TEMPERATURES. SOLD AS A COMPRESSED GAS OR LIQUID IN STEEL CYLINDERS.]
Emergency overview	:	WARNING! GAS: CONTENTS UNDER PRESURE. Do not puncture or incinerate container. Can cause rapid suffocation. May cause severe frostbite. LIQUID: Extremely cold liquid and gas under pressure. Can cause rapid suffocation. May cause severe frostbite. Do not puncture or incinerate container. Contact with rapidly expanding gases or liquids can cause frostbite.
Routes of entry	:	Inhalation
Potential acute health effects		
Eyes	:	Contact with rapidly expanding gas may cause burns or frostbite. Contact with cryogenic liquid can cause frostbite and cryogenic burns.
Skin	:	Contact with rapidly expanding gas may cause burns or frostbite. Contact with cryogenic liquid can cause frostbite and cryogenic burns.
Inhalation	:	Acts as a simple asphyxiant.
Ingestion	:	Ingestion is not a normal route of exposure for gases. Contact with cryogenic liquid can cause frostbite and cryogenic burns.
Potential chronic health effects	:	**CARCINOGENIC EFFECTS**: Not available. **MUTAGENIC EFFECTS**: Not available. **TERATOGENIC EFFECTS**: Not available.
Medical conditions aggravated by over-exposure	:	Acute or chronic respiratory conditions may be aggravated by overexposure to this gas.

See toxicological information (section 11)

Section 3. Composition, Information on Ingredients

Name	CAS number	% Volume	Exposure limits
Nitrogen	7727-37-9	100	Oxygen Depletion [Asphyxiant]

Section 4. First aid measures

No action shall be taken involving any personal risk or without suitable training.If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus.It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

Eye contact : Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately.

Skin contact : In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention immediately.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Inhalation : Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Ingestion : As this product is a gas, refer to the inhalation section.

Section 5. Fire-fighting measures

Flammability of the product : Non-flammable.

Products of combustion : Decomposition products may include the following materials:
nitrogen oxides

Fire-fighting media and instructions : Use an extinguishing agent suitable for the surrounding fire.

Apply water from a safe distance to cool container and protect surrounding area. If involved in fire, shut off flow immediately if it can be done without risk.

Contains gas under pressure. In a fire or if heated, a pressure increase will occur and the container may burst or explode.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions : Immediately contact emergency personnel. Keep unnecessary personnel away. Use suitable protective equipment (section 8). Shut off gas supply if this can be done safely. Isolate area until gas has dispersed.

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Methods for cleaning up : Immediately contact emergency personnel. Stop leak if without risk. Note: see section 1 for emergency contact information and section 13 for waste disposal.

Section 7. Handling and storage

Handling : High pressure gas. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.
Never allow any unprotected part of the body to touch uninsulated pipes or vessels that contain cryogenic liquids. Prevent entrapment of liquid in closed systems or piping without pressure relief devices. Some materials may become brittle at low temperatures and will easily fracture.

Storage : Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).
For additional information concerning storage and handling refer to Compressed Gas Association pamphlets P-1 Safe Handling of Compressed Gases in Containers and P-12 Safe Handling of Cryogenic Liquids available from the Compressed Gas Association, Inc.

Section 8. Exposure controls/personal protection

Engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Personal protection

Eyes : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or dusts.

When working with cryogenic liquids, wear a full face shield.

Skin : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

The applicable standards are (US) 29 CFR 1910.134 and (Canada) Z94.4-93

Hands : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.

Insulated gloves suitable for low temperatures

Personal protection in case of a large spill : Self-contained breathing apparatus (SCBA) should be used to avoid inhalation of the product.

Product name	
nitrogen	Oxygen Depletion [Asphyxiant]

Consult local authorities for acceptable exposure limits.

Section 9. Physical and chemical properties

Molecular weight : 28.02 g/mole

Molecular formula : N2

Boiling/condensation point : -195.8°C (-320.4°F)

Melting/freezing point : -210°C (-346°F)

Critical temperature : -146.9°C (-232.4°F)

Vapor density : 0.967 (Air = 1) Liquid Density@BP: 50.46 lb/ft3 (808.3 kg/m3)

Specific Volume (ft^3/lb) : 13.8889

Gas Density (lb/ft^3) : 0.072

Section 10. Stability and reactivity

Stability and reactivity : The product is stable.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Toxicity data

Other toxic effects on humans : No specific information is available in our database regarding the other toxic effects of this material to humans.

Specific effects

Carcinogenic effects : No known significant effects or critical hazards.

Mutagenic effects : No known significant effects or critical hazards.

Reproduction toxicity : No known significant effects or critical hazards.

Section 12. Ecological information

Aquatic ecotoxicity

Not available.

Environmental fate : Not available.

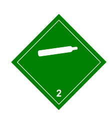
Environmental hazards : No known significant effects or critical hazards.

Toxicity to the environment : Not available.

Section 13. Disposal considerations

Product removed from the cylinder must be disposed of in accordance with appropriate Federal, State, local regulation.Return cylinders with residual product to Airgas, Inc.Do not dispose of locally.

Section 14. Transport information

Regulatory information	UN number	Proper shipping name	Class	Packing group	Label	Additional information
DOT Classification	UN1066 UN1977	NITROGEN, COMPRESSED Nitrogen, refrigerated liquid	2.2	Not applicable (gas).		**Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: 75 kg **Cargo aircraft** Quantity limitation: 150 kg
TDG Classification	UN1066 UN1977	NITROGEN, COMPRESSED Nitrogen, refrigerated liquid	2.2	Not applicable (gas).		**Explosive Limit and Limited Quantity Index** 0.125 **Passenger Carrying Road or Rail Index** 75

Nitrogen						
Mexico Classification	UN1066 UN1977	NITROGEN, COMPRESSED Nitrogen, refrigerated liquid	2.2	Not applicable (gas).		-

“Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product.”

Section 15. Regulatory information

United States

U.S. Federal regulations : **United States inventory (TSCA 8b):** This material is listed or exempted.

SARA 302/304/311/312 extremely hazardous substances: No products were found.
SARA 302/304 emergency planning and notification: No products were found.
SARA 302/304/311/312 hazardous chemicals: nitrogen
SARA 311/312 MSDS distribution - chemical inventory - hazard identification: nitrogen: Sudden release of pressure

Clean Water Act (CWA) 307: No products were found.

Clean Water Act (CWA) 311: No products were found.

Clean Air Act (CAA) 112 accidental release prevention: No products were found.

Clean Air Act (CAA) 112 regulated flammable substances: No products were found.

Clean Air Act (CAA) 112 regulated toxic substances: No products were found.

State regulations : **Connecticut Carcinogen Reporting:** This material is not listed.
Connecticut Hazardous Material Survey: This material is not listed.
Florida substances: This material is not listed.
Illinois Chemical Safety Act: This material is not listed.
Illinois Toxic Substances Disclosure to Employee Act: This material is not listed.
Louisiana Reporting: This material is not listed.
Louisiana Spill: This material is not listed.
Massachusetts Spill: This material is not listed.
Massachusetts Substances: This material is listed.
Michigan Critical Material: This material is not listed.
Minnesota Hazardous Substances: This material is not listed.
New Jersey Hazardous Substances: This material is listed.
New Jersey Spill: This material is not listed.
New Jersey Toxic Catastrophe Prevention Act: This material is not listed.
New York Acutely Hazardous Substances: This material is not listed.
New York Toxic Chemical Release Reporting: This material is not listed.
Pennsylvania RTK Hazardous Substances: This material is listed.
Rhode Island Hazardous Substances: This material is not listed.

Canada

WHMIS (Canada) : Class A: Compressed gas.

CEPA Toxic substances: This material is not listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is not listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

United States

Nitrogen

Label requirements : GAS:
CONTENTS UNDER PRESURE.
Do not puncture or incinerate container.
Can cause rapid suffocation.
May cause severe frostbite.
LIQUID:
Extremely cold liquid and gas under pressure.
Can cause rapid suffocation.
May cause severe frostbite.

Canada

Label requirements : Class A: Compressed gas.

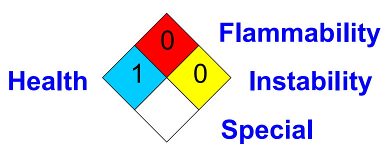
Hazardous Material Information System (U.S.A.) :

Health	1
Flammability	0
Physical hazards	0

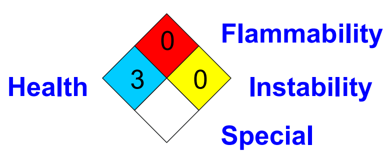
liquid:

Health	3
Fire hazard	0
Reactivity	0
Personal protection	

National Fire Protection Association (U.S.A.) :



liquid:



Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Material Safety Data Sheet

June 1, 1999

YSI Incorporated
1725 Brannum Lane
Yellow Springs, OH 45387
USA

C-P# 05478-60

Information and Emergency Phone: (937) 767-7241

SECTION 1 - MATERIAL IDENTIFICATION

PRODUCT NAME: **YSI 3682 Zobell Solution** (ORP Cal. Solution) FORMULA: n/ap
Chemical Type: Inorganic chloride / cyanide
CAS No. n/app

SECTION 2 - HAZARDOUS / IMPORTANT INGREDIENTS

Chemical	CAS No.	PERCENT	PEL/TLV	CARCINOGEN (OSHA, NTP, IARC)
Potassium chloride	7447-40-7	72 - 78%	none	no
Potassium ferrocyanide, trihydrate	14459-95-1	10 - 15%	none	no
Potassium ferricyanide	13746-66-2	10 - 15%	none	no

SECTION 3 - CHEMICAL AND PHYSICAL PROPERTIES

Appearance: white powder
Odor: none
pH: neutral
Water Solubility: infinite
Evaporation Rate: n/av

Boiling Point: n/av
Melting Point: n/av
Specific Gravity: n/av
Vapor Pressure: n/ap
Vapor Density: n/ap

SECTION 4 - FIRE AND EXPLOSION HAZARDS

Flash Point: none Explosive Limits: none
Extinguishing Media: n/ap
Special Firefighting Procedures and Hazards: Material is not combustible. May emit toxic fumes when heated, such as NOx, HCN. HCl. Wear protection as described in Section 6.

SECTION 5 - REACTIVITY INFORMATION

Stable: X Unstable: ______ Precautions: none known
Hazardous Polymerization: Occurs: ______ Does Not Occur: X
Incompatibility: strong acids and oxcidizing agents.
Hazardous Decomposition Products: When heated, possibly NOx, HCN, HCl.

SECTION 6 - HEALTH HAZARDS / PROTECTIVE MEASURES / FIRST AID

Inhalation:

Possible irritation from dusts. (see CHRONIC below)

Use a NIOSH approved respirator for dusts. Get supplier recommendations. Provide adequate ventilation. Minimize dusty conditions.

Remove to fresh air and provide artificial respiration if needed.

Skin:

Possible irritation from dusts. (see CHRONIC below)

Wear dust-proof gloves and other body protection as needed. Minimize dusty conditions.

Wash exposed areas with soap and water for 15 minutes. Remove contaminated clothing, and wash before re-using.

Eyes:

Possible irritation from dust.

Wear dust barrier goggles. Eliminate dusty conditions.

Flush with water for 15 minutes.

Ingestion

No effects expected from normal use and minor amounts ingested. Large amounts, over 1 tablespoon, can cause digestive system upset s. (see CHRONIC below)

Reduce dusting. Avoid mouth breathing. Use facemask. Provide adequate ventilation.

Avoid swallowing. Spit out. Drink large amounts of water. Induce vomiting if person is conscious. Otherwise, and if effects persist, get medical attention.

CHRONIC EFFECTS: None reported for this material. “Cyanides” in general are often reported as toxic to humans. Therefore, it is recommended that exposure via skin, inhalation, and ingestion be limited.

IN ALL CASES: GET MEDICAL ATTENTION IF EFFECTS PERSIST.

Most likely routes of entry: skin, eyes, ingestion.

SECTION 7 - PRECAUTIONS FOR SAFE HANDLING AND USE

Spills and Leaks: Take up powder in any container and hold for disposal. Flush residual to sewer or ground. Provide personal protection as described in Section 6.

Storage and Handling: Keep containers closed. Discard any material that may be contaminated. Minimize dusting.

Waste Disposal: Is not listed as RCRA hazardous waste at this date. Cyanides are restricted in water disposed to streams and to sewers. Therefore, landfill disposal is indicated; check with local disposal companies.

Empty Containers: Rinse well. Dispose as appropriate for glass and plastic containers.

SECTION 8 - REGULATORY INFORMATION

DOT: Not regulated.
SARA Title III, S.313, Form R: Nothing reportable.

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Buffer Solution pH 10.01 ± 0.02
Catalog Number: 2283649

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00370
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: May cause irritation.
Date of MSDS Preparation:
Day: 27
Month: February
Year: 2008

2. COMPOSITION / INFORMATION ON INGREDIENTS

Demineralized Water
CAS No.: 7732-18-5
TSCA CAS Number: 7732-18-5
Percent Range: > 99.0
Percent Range Units: volume / volume
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: No effects anticipated.

Other components, each
CAS No.: Not applicable
TSCA CAS Number: Not applicable
Percent Range: < 1.0
Percent Range Units: volume / volume
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Clear, blue
Odor: None

HMIS:
Health: 1
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 0
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation
Skin Absorption: No effects anticipated
Target Organs: Not applicable
Ingestion: None reported
Target Organs: None reported
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: None reported
Chronic Effects: None reported
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: None reported
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with plenty of water. Call physician if irritation develops.
Ingestion (First Aid): Give large quantities of water. Call physician immediately.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: Material will not burn.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not applicable

Hazardous Combustion Products: None
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Stop spilled material from being released to the environment.
Clean-up Technique: Cover spilled material with a dry acid, such as citric or boric. Scoop up slurry into a large beaker. Adjust to a pH between 6 and 9 with an acid, such as sulfuric or citric. Flush reacted material to the drain with a large excess of water.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: None

7. HANDLING / STORAGE

Handling: Avoid contact with eyes Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Protect from: heat Keep container tightly closed when not in use.
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves lab coat
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Clear, blue
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 10.0
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: ~100°C (~212°F)
Melting Point: ~0°C (~32°F)
Specific Gravity (water = 1): 0.990

Evaporation Rate (water = 1): 0.76
Volatile Organic Compounds Content: Not applicable
Partition Coefficient (n-octanol / water): Not determined
Solubility:
Water: Soluble
Acid: Soluble
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Heat Evaporation
Reactivity / Incompatibility: None reported
Hazardous Decomposition: None reported
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported
Mutation Data: None reported
Reproductive Effects Data: None reported
Ingredient Toxicological Data: None reported

12. ECOLOGICAL INFORMATION

Product Ecological Information: No information available for this product.

Ingredient Ecological Information: None reported

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: None
Special Instructions (Disposal): Adjust to a pH between 6 and 9 with an acid, such as sulfuric or citric. Open cold water tap completely, slowly pour the reacted material to the drain.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--

DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA
I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit Hazard Class: 9 UN Number 3316.

15. REGULATORY INFORMATION

U.S. Federal Regulations:
O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)
E.P.A.:
S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard
S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.
--
302 (EHS) TPQ (40 CFR 355): Not applicable
304 CERCLA RQ (40 CFR 302.4): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
Clean Water Act (40 CFR 116.4): Not applicable
RCRA: Contains no RCRA regulated substances.
C.P.S.C.: Not applicable
State Regulations:
California Prop. 65: No Prop. 65 listed chemicals are present in this product.
Identification of Prop. 65 Ingredient(s): None
Trade Secret Registry: Not applicable
National Inventories:
U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).
TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Buffer
References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Technical Judgment. In-house information.

Revision Summary: Updates in Section(s) 14,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Buffer Solution pH 4.01 ± 0.02
Catalog Number: 2283449

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00368
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: Practically non-toxic.
Date of MSDS Preparation:
Day: 09
Month: February
Year: 2008

2. COMPOSITION / INFORMATION ON INGREDIENTS

Demineralized Water
CAS No.: 7732-18-5
TSCA CAS Number: 7732-18-5
Percent Range: >95.0
Percent Range Units: weight / weight
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: No effects anticipated.

Other components, each
CAS No.: Not applicable
TSCA CAS Number: Not applicable
Percent Range: < 1.0
Percent Range Units: volume / volume
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

Potassium Acid Phthalate
CAS No.: 877-24-7

TSCA CAS Number: 877-24-7
Percent Range: 1.0 - 5.0
Percent Range Units: weight / volume
LD50: Oral rat LDLo = 3200 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation.

---

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Clear, red liquid
Odor: None

HMIS:
Health: 0
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 0
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: No effects are anticipated
Skin Contact: No effects are anticipated
Skin Absorption: No effects anticipated
Target Organs: Not applicable
Ingestion: No Effects Anticipated
Target Organs: Not applicable
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: None reported
Chronic Effects: No effects anticipated
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: None reported
Toxicologically Synergistic Products: None reported

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4. FIRST AID

Eye Contact: Flush eyes with water. Call physician if irritation develops.
Skin Contact (First Aid): Wash skin with soap and plenty of water.
Ingestion (First Aid): Give large quantities of water. Call physician immediately.

Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: Material will not burn.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not applicable
Hazardous Combustion Products: Not applicable
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Stop spilled material from being released to the environment.
Clean-up Technique: Cover spilled material with an alkali, such as soda ash or sodium bicarbonate. Scoop up slurry into a large beaker. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Flush reacted material to the drain with a large excess of water. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: None

7. HANDLING / STORAGE

Handling: Avoid contact with eyes Wash thoroughly after handling.
Storage: Keep container tightly closed when not in use.
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Clear, red liquid
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 4.01
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: > 100°C (> 212°F)
Melting Point: < 0°C (< 32°F)
Specific Gravity (water = 1): 1.002
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not applicable
Partition Coefficient (n-octanol / water): Not determined
Solubility:
Water: Soluble
Acid: Soluble
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures
Reactivity / Incompatibility: None reported
Hazardous Decomposition: None reported
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported
Mutation Data: None reported
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Potassium Acid Phthalate: Oral rat LD_{Lo} = 3200 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: --
No ecological data available for the ingredients of this product.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: None
Special Instructions (Disposal): Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Open cold water tap completely, slowly pour the reacted material to the drain.

Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

---

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA
I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit Hazard Class: 9 UN Number 3316.

---

15. REGULATORY INFORMATION

U.S. Federal Regulations:
O.S.H.A.: This product does not meet the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)
E.P.A.:
S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): This product is not hazardous under 29 CFR.1910.1200 and therefore is not covered by Title III under SARA.
S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.
--
302 (EHS) TPQ (40 CFR 355): Not applicable
304 CERCLA RQ (40 CFR 302.4): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
Clean Water Act (40 CFR 116.4): Not applicable
RCRA: Contains no RCRA regulated substances.
C.P.S.C.: Not applicable
State Regulations:
California Prop. 65: No Prop. 65 listed chemicals are present in this product.
Identification of Prop. 65 Ingredient(s): --
Trade Secret Registry: Not applicable

National Inventories:

U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).

TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Buffer

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Technical Judgment. In-house information. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991.

Revision Summary: Updates in Section(s) 14,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

In-Situ Inc.
221 East Lincoln Avenue • Fort Collins, CO 80524 USA
1 800 446 7488 • 1 970 498 1500 (Tel)
1 970 498 1598 (Fax)
WWW.IN-SITU.COM

MATERIAL SAFETY DATA SHEET

I. Chemical Product and Company Identification

Product Name:	Manufacturer:	Emergency Contact:
Quick Cal Solution	In-Situ Inc. 221 East Lincoln Avenue Fort Collins, Colorado 80524 Telephone: 970 498 1500 Fax: 970 498 1598	INFOTRAC Emergency Response Hotline: 1-800-535-5053 (in the U.S. and Canada) 1-352-323-3500 www.infotrac.net
Hazardous Shipping Label:	**Dot** None	**IATA** None

II. Ingredients

Hazardous Components Specific Chemical Identity: Common Names	CAS NO.	%	OSHA PEL	ACGIH TLV	LD_{50} (mg/Kg)
Potassium Dihydrogen Phosphate (KH_2PO_4)	7778-77-0	< 1.0	None Listed	None Listed	None Listed
Potassium Chloride (KCl)	7447-40-7	< 1.0	None Listed	None Listed	3020 (ORL-RAT)
Sodium Hydroxide, NaOH	1310-73-2	< 1.0	None Listed	None Listed	1600 (ORL-RAT)
Potassium ferricyanide ($K_3Fe(CN)_6$)	13746-66-2	< 1.0	None Listed	None Listed	None Listed
Potassium ferricyanide trihydrate ($K_3Fe(CN)_6\ 3H_2O$)	14459-95-1	< 1.0	None Listed	None Listed	None Listed
Deionized Water, H_2O	7732-18-5	> 98	None Listed	None Listed	190,000 (IPR-MUS)

III. Physical Data

Boiling Point @ 750 mm Hg	100 ^oC	**Freezing Point**	0 ^oC
pH @ 25 ^oC	7.00	**Vapor Pressure @ 25 ^oC**	NA
Volatiles % By Wt.	NA	**Solubility in Water, % by Wt @ 25 ^oC**	Miscible
Vapor Density (Air = 1)	NA	**Evaporation Rate (Butyl, Acetate = 1)**	NA
Specific Gravity (Water = 1)	1.0	**Odor**	odorless
Appearance	Light green Liquid		

IV. Fire And Explosion Hazard Data

Flash Point (Test Method)	Not Flammable	**Autoignition Temperature**	NA
Flammable Limits in air, % by volume		**Lower** NA	**Upper** NA
Extinguishing Media	Water, CO_2, Dry Chemical , Foam Spray	**Special Fire-Fighting Procedures**	None, non-flammable
Unusual Fire & Explosion Hazards	None		

* NA – Not Applicable/not available

V. Reactivity Data

Stability	*Unstable*	*Stable* X
Conditions to Avoid	None	
Incompatibility (Materials to Avoid)	None	
Hazardous Decomposition Products	None	
Hazardous Polymerization	Cannot Occur	

VI. Health Hazard Data

Routes of Entry	***Inhalation*** Yes	***Skin*** Yes	***Ingestion*** Yes
Health Hazards	***Acute***	Irritation may occur in case of eye or skin contact. Irritation may also occur to mucous membranes from vapors.	
	Chronic	This substance is toxic to blood, lungs, mucous membranes.	
Carcinogenicity	***NTP*** Not Found	***IARC Monographs*** Not Found	***OSHA Regulated*** Not Found
Signs and Symptoms of Exposure	Irritation		
Medical Conditions Generally Aggravated by Exposure	Could Aggravate Diseases of Skin		
Emergency And First Aid Procedures	If skin contact occurs, wash off contact area with water. If ingested, give large amounts of water. Do not induce vomiting. Contact physician.		

VII. Precautions for Safe Handling and Use

Steps to be Taken In Case Material is Released or Spilled	Dilute with water and set aside for diposal
Waste Disposal Method	Consult Federal, State and Local laws for proper disposal.
Precautions To Be Taken In Handling and Storing	Suitable for any general handling storage. NFPA Rating: Scale (0-4); Health –2, Fire – 0, Reactivity – 0, Specific - None
Other Precautions	Do Not Ingest!

VI. Control Measures

Respiratory Protection (specific type)	None	
Ventilation	***Local Exhaust*** None	***Special*** None
	Mechanical (General) Use in Fume Hood	***Other*** None
Protective Gloves Yes	**Eye Protection** Safety Glasses	**Other Protective Clothing or Equipment** None
Work/Hygienic Practices	Emergency eyewash should be available. Wash hands after working with this product	

APPENDIX D

PORTABLE GENERATOR HAZARDS

Consumer Product Safety Commission Safety Alert

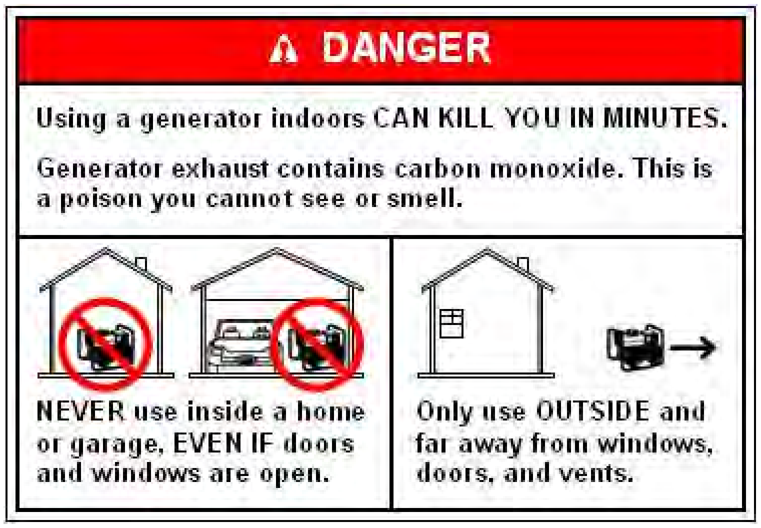
Portable Generator Hazards

Portable generators are useful when temporary or remote electric power is needed, but they also can be hazardous. The primary hazards to avoid when using a generator are carbon monoxide (CO) poisoning from the toxic engine exhaust, electric shock or electrocution, fire and burns.

Every year, people die in incidents related to portable generator use. Most of the incidents associated with portable generators reported to CPSC involve CO poisoning from generators used indoors or in partially-enclosed spaces.

Carbon Monoxide Hazards

When used in a confined space, generators can produce high levels of CO within minutes. When you use a portable generator, remember that you cannot see or smell CO. Even if you do not smell exhaust fumes, you may still be exposed to CO.



Danger labels are required on all portable generators manufactured or imported on or after May 14, 2007.

If you start to feel sick, dizzy, or weak while using a generator, get to fresh air **RIGHT AWAY. DO NOT DELAY**. The CO from generators can rapidly kill you.

Follow these safety tips to protect against CO poisoning.

- **NEVER** use a generator inside homes, garages, crawlspaces, sheds, or similar areas, even when using fans or opening doors and windows for ventilation. Deadly levels of carbon monoxide can quickly build up in these areas and can linger for hours, even after the generator has shut off.
- Follow the instructions that come with your generator. Locate the unit outdoors and far from doors, windows, and vents that could allow CO to come indoors.
- Install battery-operated CO alarms or plug-in CO alarms with battery back-up in your home, according to the manufacturer's instructions. CO alarms should be certified to the requirements of the latest safety standards (UL 2034, IAS 6-96, or CSA 6.19.01). Test batteries monthly.

To avoid CO poisoning when using generators:

- Never run generators indoors, including garages, basements, crawlspaces and sheds.
- Get to fresh air right away if you start to feel dizzy or weak.

Electrical Hazards

- Generators pose a risk of shock and electrocution, especially if they are operated in wet conditions. If you must use a generator when it is wet outside, protect the generator from moisture to help avoid the shock/electrocution hazard, but do so without operating the generator indoors or near openings to any building that can be occupied in order to help avoid the CO hazard. Operate the generator under an open, canopy-like structure on a dry surface where water cannot reach it or puddle or drain under it. Dry your hands, if wet, before touching the generator.

- Connect appliances to the generator using heavy-duty extension cords that are specifically designed for outdoor use. Make sure the wattage rating for each cord exceeds the total wattage of all appliances connected to it. Use extension cords that are long enough to allow the generator to be placed outdoors and far away from windows, doors and vents to the home or to other structures that could be occupied. Check that the entire length of each cord is free of cuts or tears and that the plug has all three prongs. Protect the cord from getting pinched or crushed if it passes through a window or doorway.

- **NEVER** try to power the house wiring by plugging the generator into a wall outlet, a practice known as “backfeeding.” This is extremely dangerous and presents an electrocution risk to utility workers and neighbors served by the same utility transformer. It also bypasses some of the built-in household circuit protection devices.

Fire Hazards

- **Never** store fuel for your generator in the home. Gasoline, propane, kerosene, and other flammable liquids should be stored outside of living areas in properly-labeled, non-glass safety containers. Do not store them near a fuel-burning appliance, such as a natural gas water heater in a garage.

- Before refueling the generator, turn it off and let it cool down. Gasoline spilled on hot engine parts could ignite.

5123/0407

Send the link for this page to a friend! Consumers can obtain this publication and additional publication information from the Publications section of CPSC's web site or by sending your publication request to info@cpsc.gov.

The U.S. Consumer Product Safety Commission is charged with protecting the public from unreasonable risks of serious injury or death from thousands of types of consumer products under the agency's jurisdiction. The CPSC is committed to protecting consumers and families from products that pose a fire, electrical, chemical, or mechanical hazard. The CPSC's work to ensure the safety of consumer products - such as toys, cribs, power tools, cigarette lighters, and household chemicals - contributed significantly to the decline in the rate of deaths and injuries associated with consumer products over the past 30 years.

To report a dangerous product or a product-related injury, call CPSC's hotline at (800) 638-2772 or CPSC's teletypewriter at (800) 638-8270, or visit CPSC's web site at www.cpsc.gov/talk.html. To join a CPSC email subscription list, please go to https://www.cpsc.gov/cpsclist.aspx. Consumers can obtain this release and recall information at CPSC's Web site at www.cpsc.gov.

APPENDIX E

EMERGENCY CONTACTS

EMERGENCY SERVICES

Security (Police/Sheriff)	911
Fire/Rescue	911
Ambulance	911
Caribou Memorial Hospital Emergency Room	208-547-3341
Portneuf Medical Center Emergency Room (Pocatello)	208-239-1800
Star Valley Hospital Emergency Room (Afton, WY)	307-885-5821
Idaho Poison Control Center	800-860-0620

EMERGENCY CONTACT NUMBERS

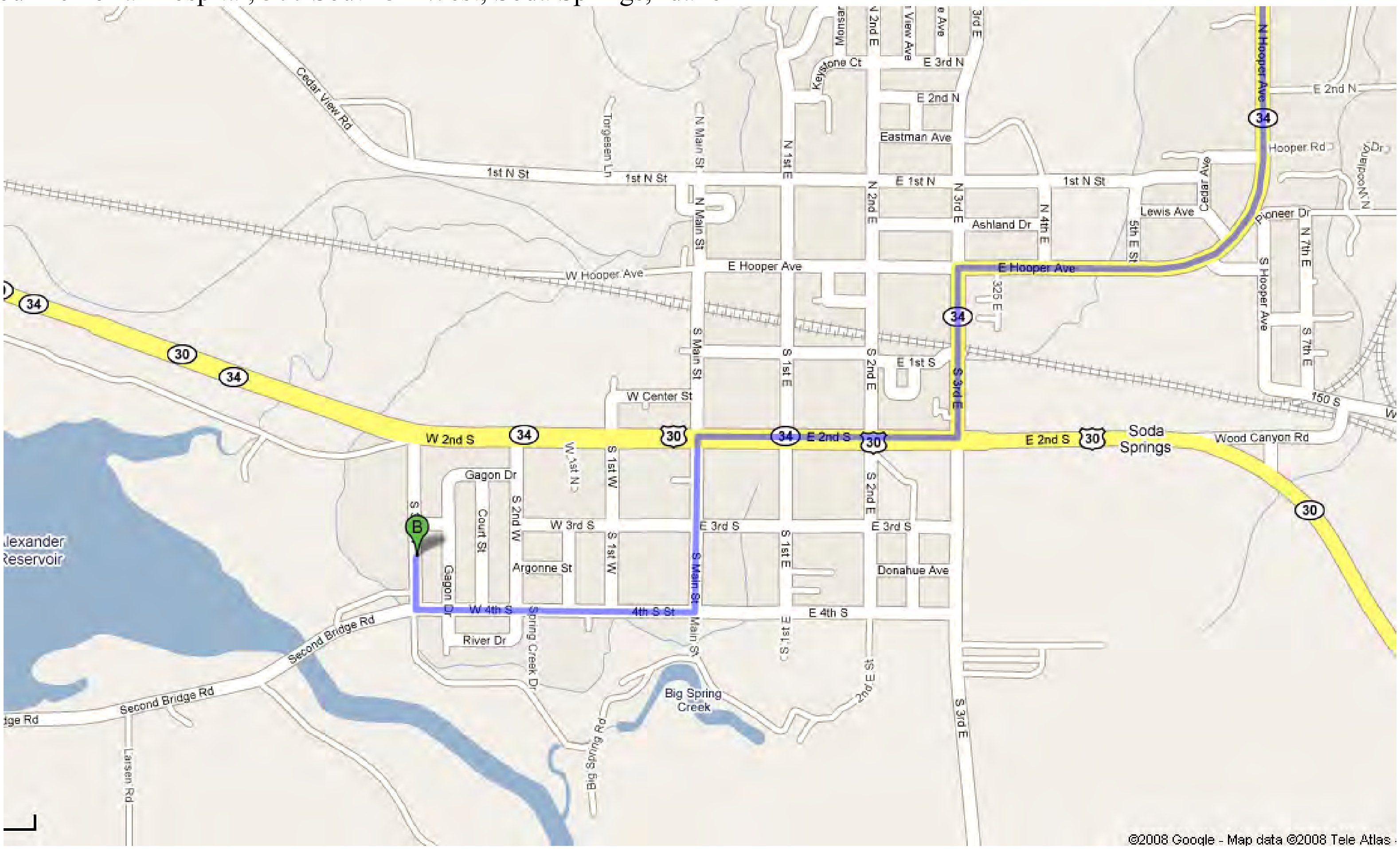
Vance Drain (MWH Project Manager)	office: 801-617-3250 cell: (b) (6) [redacted]
Cary Foulk (RI/FS Task Manager)	office: 970-871-4371 cell: (b) (6) [redacted]
Emily Yeager (On Site Safety Officer)	cell: (b) (6) [redacted]
Rachel Roskelley (P_4 Production Project Manager)	office: 208-547-1248 cell: (b) (6) [redacted]
Emergency	911

Note: It may be necessary to dial a ‘9’ to access an outside line at mine sites when calling.

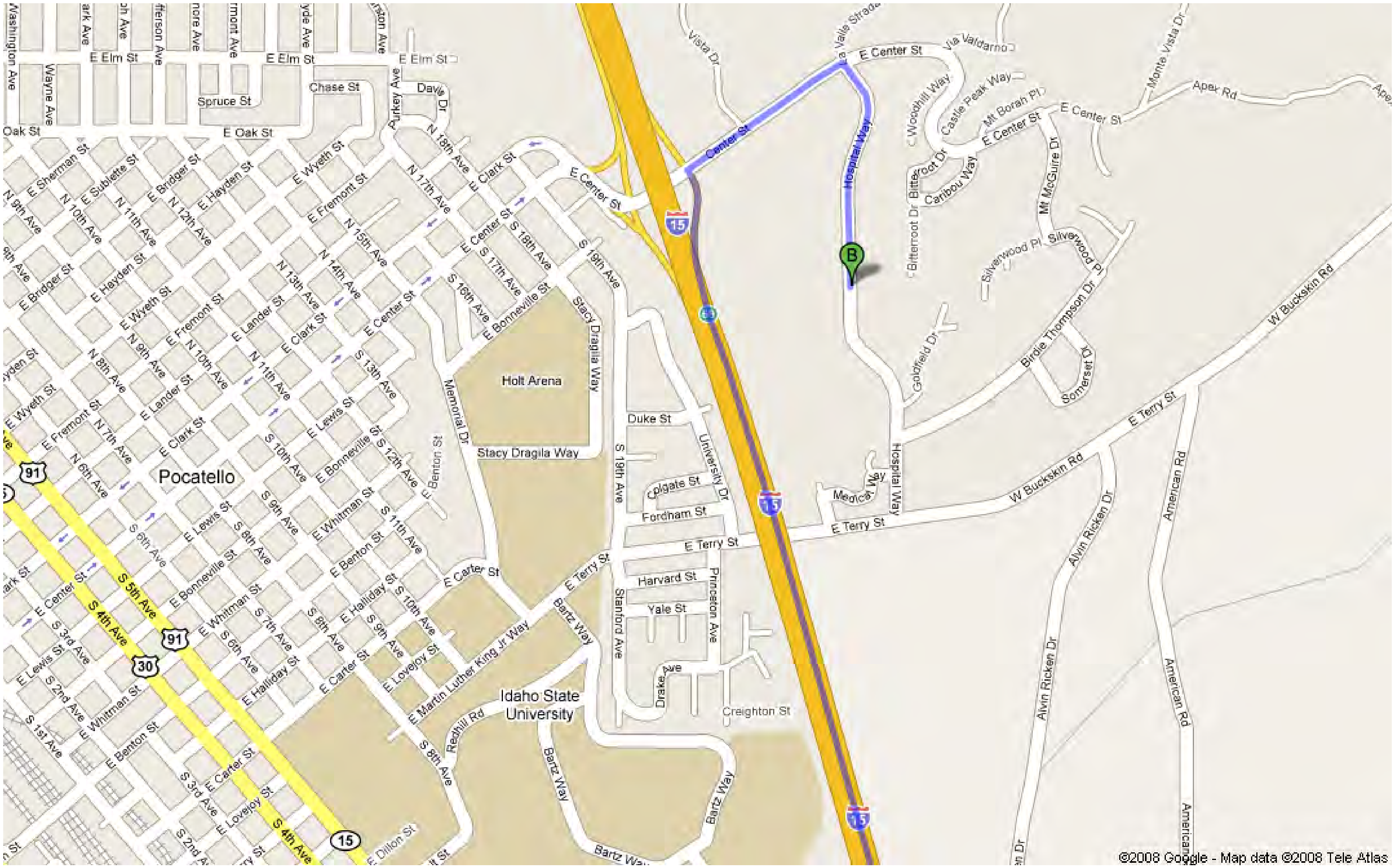
HOSPITAL FACILITIES

The closest hospital and the specific route to the hospital will depend on where field activities are taking place. The following are the hospitals closest to the project sites:

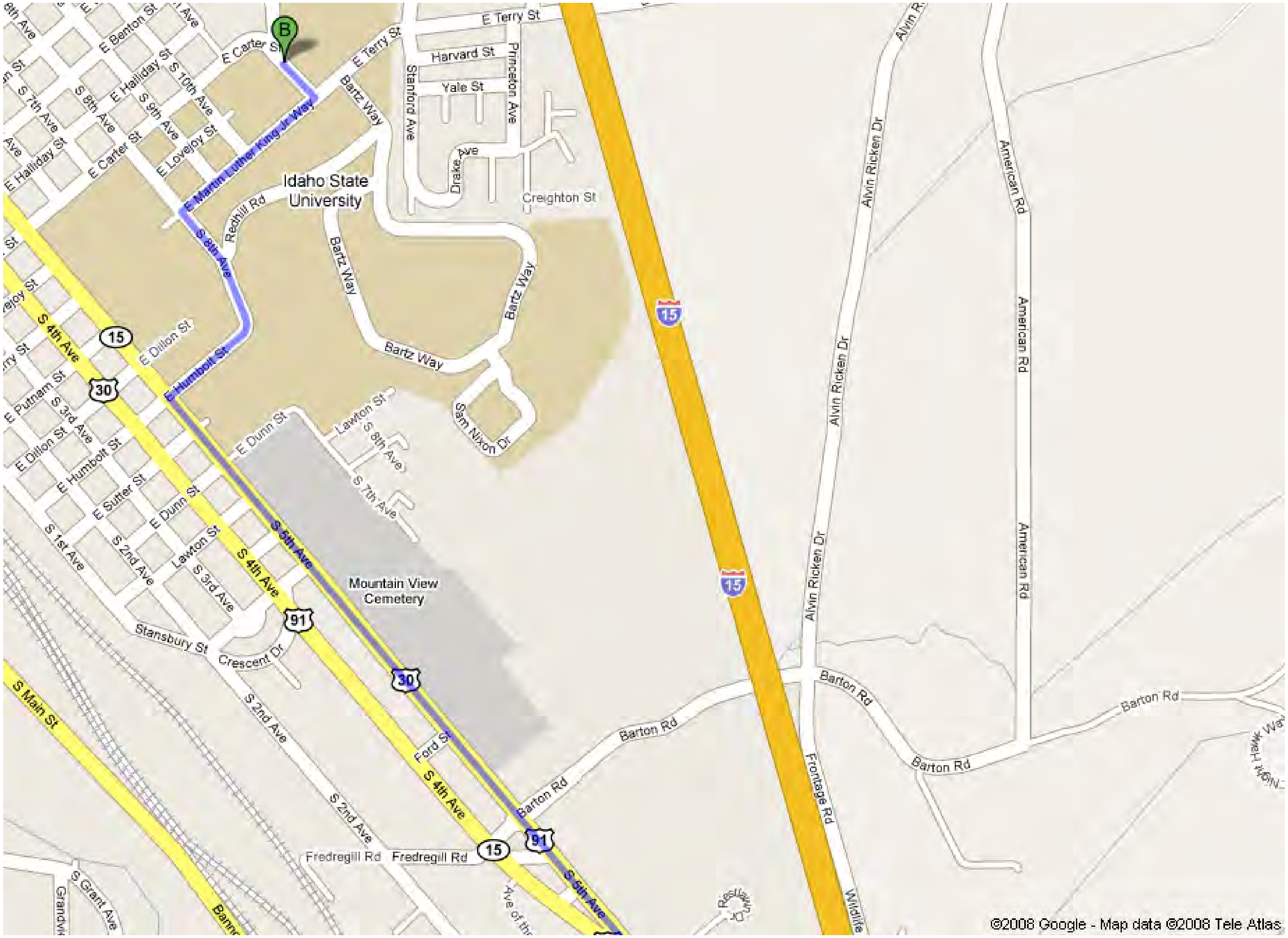
Caribou Memorial Hospital, 300 South 3rd West, Soda Springs, Idaho



Portneuf Medical Center (East Campus), 777 Hospital Way, Pocatello, Idaho, At Pine Ridge Mall



Portneuf Medical Center (West Campus), 651 Memorial Drive, Pocatello, Idaho



Star Valley Medical Center	307-886-5800 (Information)
110 Hospital Lane	307-886-5821 (Emergency Room)
Afton, Wyoming	911 (Search and Rescue/Sheriff's Dispatch)

In general, to get to the Caribou Memorial Hospital, proceed to Highway 30 in Soda Springs, which is also known as 2nd South. Proceed to 3rd West, and turn south to 3rd South. To get to the Portneuf Medical Center (East Campus), proceed to I-15 and take the Clark Street exit. The hospital is at the top of a hill and is visible from the freeway. To get to the Portneuf Medical Center (West Campus), proceed to I-15 through Pocatello and take the Clark Street exit. Drive West on Clark, turning South on 15th Street. The West Campus is on the right side. To get to the Star Valley Hospital, proceed to Highway 89 and turn onto Hospital Lane. When making calls from mine offices, it may be necessary to dial '9' to access an outside line.

APPENDIX F

PERSONAL ACKNOWLEDGEMENT FORM

PERSONAL ACKNOWLEDGMENT FORM

HEALTH AND SAFETY PROGRAM

____

PROGRAM OR SITE

As a component of the Health and Safety Plan designed to provide personnel safety during the investigation of the southeast Idaho phosphate resource area, you are required to read and understand the Health and Safety Plan. When you have fulfilled this requirement, please sign and date this personal acknowledgment form, and return the form to the On-Site Safety Officer.

____________________________ ____________________________

Signature Name (Printed)

____

Date

APPENDIX G

MONSANTO CONTRACTOR/GUEST ES&H SITE GUIDELINES

APPENDIX H

PRE-JOB RISK ANALYSIS WORKSHEET

APPENDIX H.1

MONSANTO PRE-JOB ANALYSIS WORKSHEET

Monsanto – Soda Springs Plant

Pre-Job Risk Analysis

Job #	
Date:	
Work Area:	

Work area inspected and the following hazards corrected:	

Work Team Signatures:				

Job Name/Title:	

Major Job Steps (Each major step is written below in this column)	**Potential Risks** (Run each job step thru the following list, identifying risks by entering the job step number from the prior column)	**Prevention Plan** (All risks identified from the previous column must have a prevention plan noted here, and detailed on the job order)
1.	Lockout/Tagout	
	Atmospheric Monitoring	
2.	Barriers/Guards	
	Housekeeping	
3.	Permitting	
	Head/face/neck protection	
4.	Eye Protection	
	Body Protection	
5.	Hand/Arm Protection	
	Legs/Feet Protection	
6.	Respiratory Protection	
	Fall Protection	
7.	Hearing Protection	
	Pinch Points	
8.	Lifting	
	Ascend/Descend	
9.	Line of Fire	
	Working Surface	
10.	Ergonomics	
	Work Pace	
11.	Tool Selection/Condition	
	Vehicle Inspection	
12.	Vehicle Operation	
	Assistance	
13.	Communication	
	Environmental Risks	
14.	Chemical Safety/MSDS	
	Electrical Clearance	

APPENDIX H.2

STANTEC RMS2 - Field Risk Assessment

Stantec

FIELD LEVEL RISK ASSESSMENT – RMS2

Project: ______________________ Project No: ______________

Client: ______________________

Location: ______________________

Type of Work: ______________________

Start Date: ______________________

Documentation and Procedure Review

1. Risk Management Strategy (RMS1) Form or HASP required Safe Work Practices (SWPs) and procedures reviewed? ☐ Yes ☐ **No***
2. Site Specific Health and Safety Plan (HASP) and/or Emergency Response Plan Reviewed? ☐ Yes ☐ **No*** ☐ N/A
3. Tested two-way communications (cell phone, satellite phone), and security measures? ☐ Yes ☐ **No***
4. Attended Prime Contractor or Constructor Health and Safety meeting on site? ☐ Yes ☐ **No*** ☐ N/A
5. Conducted site safety meeting with Subcontractors? ☐ Yes ☐ **No*** ☐ N/A
6. Are there any new or unexpected hazards not identified in the RMS1/HASP? ☐ Yes ☐ No
   If yes, include in the Job Safety Analysis (JSA).
7. Working alone or remote work? ☐ Yes ☐ No
   If yes, Working Alone – Field/Safe Work Form must be completed.

Notifications and Permits

8. Are work permits required for this site? ☐ Yes ☐ No
   If yes, have they been completed and submitted as required? ☐ Yes ☐ **No***
9. Are utility locates required for this site? ☐ Yes ☐ No
   If yes, have they been completed and reviewed? ☐ Yes ☐ **No***
10. Does the Client require any notification prior to starting the work? ☐ Yes ☐ No
    If yes, has the notification been provided? ☐ Yes ☐ **No***

***Contact your Project Manager immediately.**

Personal Protective Equipment

List specific equipment as needed. Verify type and inspect condition.

☐ Head Protection Type: ________	☐ Hearing Protection: ________	☐ Gloves Type: ________
☐ Foot Protection Type: ________	☐ Respiratory Protection (type): ________	☐ Water Safety Gear: ________
☐ Eye Protection Type: ________	☐ Fire Retardant Coveralls: ________	☐ ________
☐ High Visibility Vest: ________	☐ Fall Protection (type): ________	☐ ________

Tools and Equipment

☐	☐	☐
☐	☐	☐
☐	☐	☐

Job Safety Analysis (JSA) – USE MONSANTO PRE-JOB ANALYSIS WORKSHEET (Appendix H.1)

Basic Job Steps	Potential Hazards	Controls to Reduce or Eliminate Hazard

Additional Discussion Items/Subcontractor Input

Date:		Subcontractor Signature:	
Team Lead/Field Supervisor Signature:		Subcontractor Signature:	
Signature:		Subcontractor Signature:	
Signature:			

Stantec

DAILY RENEWAL – RMS2/FIELD-LEVEL RISK ASSESSMENT

Job Number:

Date:	**Weather:**		
Identified changes to risk and additional controls (e.g.: new crew member, impact on others, inclement weather, etc.):			
Field Supervisor/Field Crew Leader (Print & Sign):			
Field Crew Signed:			
Sub-Contractor:			
Date:	**Weather:**		
Identified changes to risk and additional controls (e.g.: new crew member, impact on others, inclement weather, etc.):			
Field Supervisor/Field Crew Leader (Print & Sign):			
Field Crew Signed:			
Sub-Contractor:			
Date:	**Weather:**		
Identified changes to risk and additional controls (e.g.: new crew member, impact on others, inclement weather, etc.):			
Field Supervisor/Field Crew Leader (Print & Sign):			
Field Crew Signed:			
Sub-Contractor:			
Date:	**Weather:**		
Identified changes to risk and additional controls (e.g.: new crew member, impact on others, inclement weather, etc.):			
Field Supervisor/Field Crew Leader (Print & Sign):			
Field Crew Signed:			
Sub-Contractor:			

APPENDIX I

DEGERSTROM ORE HAULROAD TRAVEL REQUIREMENTS

ORE HAULROAD TRAVEL REQUIREMENTS

VISITORS

Haulroad Safety

There are two different types of haulroads used by Degerstrom Ventures. The system of roads used for the hauling of materials between the pit and dumps or pit and ore stockpile. This system is referred to as simply haulroads. The other type of haulroad is the Ore Haulroad which is a 19 mile paved haulroad used for hauling ore from the tipple to the ore stacker near the Monsanto Plant Site.

Both of these haulroads share some safety rules but also have some safety rules that are specific to that particular road. It is important to understand the differences between these two road systems and obey the traffic rules that assure personal safety and help maintain safe haulroad traffic.

Sections of the haulroads in the mine are shared through a co-operative agreement with Agrium. These present additional hazards and restrictions that are also addressed in this section.

Right hand traffic is observed on all roads to, from and at the mine; unless otherwise posted. Large pieces of mobile equipment have very limited visibility, large blind spots, and often have extremely long stopping distances: so be aware of this and give mobile equipment plenty of room when approaching them from any direction. It is important to be cautious, pay attention to what is going on around you at all times and particularly avoid equipment in blind spots. Always stay in areas where you can see the operators of mobile equipment – ***"See & Be Seen"*** when traveling on all roads in and around the mine. *If you cannot see the operator, the operator cannot see you.*

General Haulroad Safety Rules

1) Obey all posted speed limits.

2) Obey all posted warning, advisory, and traffic signs.

3) Always wear seatbelts.

4) Watch for wildlife crossing.

5) Always drive with headlights on.

6) Adjust your speed for weather and road conditions.

7) Loaded haul trucks have the right of way.

8) Always assume that unless you can see the operator they cannot see you.

9) Give plenty of clearance to all mobile equipment. Remember: large equipment has very limited visibility and large blind spots.

10) When following a haul truck stay far enough back that you can see the driver's side mirror, that way the operator can see you.

11) Never approach mobile equipment from the rear. Avoid this large blind spot and approach from the driver's side. Never park directly behind any mobile equipment.

12) Be alert for material that may fall off the beds of loaded trucks.

13) Never drive past, over or around any type of road barricade.

14) Pay attention to horns, alarms and signals on all mobile equipment.

Ore Haul Road

The Ore Haul Road runs from the tipple at the mine to the unloading facility at the plant. This paved road was designed for ore hauling, but the upper portion above the Blackfoot River Road/Ballard intersection serves as the access road to the mine. Traffic between the Ballard intersection and the plant is restricted to ore trucks, service equipment, and small vehicles equipped with the proper two-way radios. All other vehicles must make prior arrangements and/or be escorted.

The Ore Haulroad crosses the Blackfoot River Road at Ballard. Traffic at this intersection is controlled by traffic lights. These lights regulate traffic on the Blackfoot River Road to allow the ore trucks to proceed through the intersection safely, without stopping. This is very important to the operation of the ore trucks, especially when the trucks are loaded with 210 tons of ore. The traffic lights are triggered by trips set in the asphalt prior to the intersection and cycle through a preset time, which allows the ore trucks to pass through the intersection before the lights change. It is important to avoid driving over the trips and triggering the traffic light cycles, tripping them may effect the cycle time and interfere with an approaching ore truck. The trips are clearly marked on the asphalt and with signs. The ore trucks have the right of way, so avoid driving over the trips, stay clear of approaching traffic, and any ore trucks that may be following behind you.

Ore trucks may be parked on the ore haul road during lunch break and if they are experiencing mechanical problems. When you are approaching these parked trucks slow down and use caution, the operator or mechanics may step out from under or around these parked trucks.

Ore Haulroad Safety Rules

1) Obey all posted speed limits.

2) Obey all posted warning, advisory, and traffic signs.

3) Always wear seatbelts.

4) Always drive with your headlights on.

5) Watch for wildlife crossing.

6) Adjust your speed for the weather and road conditions.

7) Ore trucks have the right of way.

8) Stay as far to the right as possible when traveling the Ore Haulroad, especially when meeting ore trucks.

9) Use extreme caution when passing an ore haul truck. Never pass on corners or hills where visibility is limited.

10) Avoid driving over the traffic light trip at Ballard and Conda crossings.

11) Never park on the paved portion of the haulroad. Always park in a spot that is clear from traffic. In case of a mechanical problem, park as far to the right as possible and turn on emergency flashers.

12) Slow down and use caution when approaching and passing ore trucks that are stopped on the ore haulroad. Operators and mechanic may be walking around these stopped trucks.

Haulroads at the Mine

There are numerous roads throughout the mine itself. These roads are used for a variety of purposes such as, to accessing various areas of the mine, drilling & blasting, and surveying. The haulroads are designed for specifically for the hauling of mine ore and waste materials.

The traffic patterns on these roads change continually during each shift, as needed. The basic rule here is to stop before entering these roads, look at the flow of the traffic and then follow. This has been posted at main entrances to haulroads with signs that read – "STOP LOOK and FOLLOW." Remember it is very important to ***"See & Be Seen."***

During drilling, loading and blasting some roads may be barricaded with signs, traffic cones or other means to prevent access to the area. This is done to prevent access to a blasting area before, during and after a shot. Never enter these barricaded areas.

Mine Haulroad Safety Rules

1) Obey all posted speed limits.

2) Obey all posted warning, advisory, and traffic signs.

3) Always wear seatbelts.

4) Drive with your headlights on.

5) Adjust your speed for weather conditions.

6) Loaded haul trucks have the right of way.

7) Never enter areas that have been barricaded.

8) **Do Not Pass** any mobile equipment or vehicles unless you have received clearance (by radio/hand signals) from the operator of that piece of equipment.

9) Be alert for material that may fall from the bed of loaded haul trucks. Keep plenty of space between you and a haul truck when following up any grades.

10) Give plenty of clearance to all mobile equipment. These large pieces of equipment have very limited visibility and large blind spots.

11) When following a haul truck, stay far enough back that you can see the driver's side mirror, that way the operator can see you.

12) Never enter marked or barricaded blasting areas.

13) Never park directly behind any mobile equipment. Always park on the driver's side. If you cannot see the operator, the operator cannot see you.

14) Pay attention to horns, alarms, and signals from mobile equipment.

15) Never park on the haulroad. Always park in a spot that is clear from traffic. In case of a mechanical problem, park as far to the right as possible and turn on emergency flashers.

GENERAL REQUIREMENTS:

- All visitors planning to drive on any haul roads shall successfully complete a specific hazard awareness training session presented by Degerstrom Ventures.
- All visitors on any haul road shall obtain Degerstrom Ventures permission for access.
- All visitors must check in and out at the Degerstrom Ventures Office before and after each visit.
- Vehicles using haul roads shall not trip the traffic lights at the Conda or Ballard Crossings.
- Posted speed limits & traffic requirements shall be followed when using the haul roads.
- Seatbelts shall be worn at all times when using the haul roads.
- Vehicle headlights shall be used when traveling the haul roads.
- Ore haul trucks are considerably larger than regular semi trucks. It requires much longer distances to stop them and they are much less maneuverable.
- Never pass a haul truck traveling on the haul road.
- When approaching a haul truck stopped along the haul road – SLOW DOWN & SOUND HORN before passing.
- Be alert for wildlife and livestock that may be on, along or crossing the roadway.
- Leave all gates along the haulroads the way that you found them.

SPECIFIC REQUIREMENTS:

1. From the stacker dump station to the gravel pit, visitors can use the haul road if they have completed the general requirements.
2. From the gravel pit to the corrals by the Fish Pond, visitors must complete the general requirements and have an approved Monsanto or Degerstrom Ventures' escort at all times.
3. From the corrals by the Fish Pond to the Ballard light, visitors can use the haul road if they have completed the general requirements.
4. From the Ballard lights to the Degerstrom Ventures Office, visitors with business to complete at the mine can use the haul road by following the requirements of the road signs.
5. From the Degerstrom Ventures Office to the tipple and mine, visitors must have a Monsanto or Degerstrom Ventures' escort or complete the general requirements plus obtain Degerstrom Ventures permission.

Degerstrom Ventures haul trucks, equipment and other vehicles shall always have the right-of-way and all vehicles shall yield to them. Visitors shall travel at their own risk. Degerstrom Ventures shall not be held responsible for their safety.

USE OF THE HAUL ROAD IS A <u>PRIVLAGE</u> GRANTED BY DEGERSTROM VENTURES. ANY VIOLATIONS OF THIS POLICY WILL RESULT IN REMOVAL FROM THE PROPERTY

RELEASE FORM (Individual)

In consideration of the permission given to me by DEGERSTROM VENTURES and/or MONSANTO/P4 PRODUCTION, L.L.C. to enter upon land owned or leased by DEGERSTROM VENTURES for the sole and exclusive purpose of _______________________________________, I, the undersigned, do hereby:

(i) Voluntarily assume all risk, whether known or unknown, of accident, loss and damage to myself and others and property resulting or arising from or in any way connected with my presence on said land;

(ii) Release and discharge DEGERSTROM VENTURES and MONSANTO/P4 PRODUCTION, L.L.C., and its successors and assignees, and its and their respective directors, officers, employees, and agents, from any and all claims, obligations, liabilities, losses, damages, costs, or expenses of any kind, (including, without limitation, attorney's fees), whether known or unknown, sustained as a result of or arising from or in any way connected with my presence on said land; and

(iii) Agree to protect, indemnify, and save harmless DEGERSTROM VENTURES and MONSANTO.P4 PRODUCTION, L.L.C., their successors and assignees, and its and their respective directors, officers, employees, and agents, from any and all claims, demands, causes of action, losses, damages, obligations, liabilities, penalties, costs, and expenses of any kind (including, without limitation, amounts paid in settlement and attorney's fees and expenses), whether known or unknown, suffered by, imposed upon, incurred by, asserted against, or arising in any way against, DEGERSTROM VENTURES and MONSANTO/P4 PRODUCTION, L.L.C. or any of their successors or assignees, or the directors, officers, employees, or agents of any of them in connection with my presence on said land regardless of whether caused by the negligence of DEGERSTROM VENTURES and MONSANTO/P4 PRODUCTION,L.L.C. or their directors, officers, employees, or agents.

IN WITNESS WHEREOF, I hereunto set my hand this __________ day of ____________, 200_.

____

Address: ____

APPENDIX J
OSHA JOB SAFETY AND HEALTH PROTECTION POSTER

U.S. Department of Labor

OSHA®
Occupational Safety and Health Administration

Job Safety and Health IT'S THE LAW!

All workers have the right to:

- A safe workplace.
- Raise a safety or health concern with your employer or OSHA, or report a work-related injury or illness, without being retaliated against.
- Receive information and training on job hazards, including all hazardous substances in your workplace.
- Request an OSHA inspection of your workplace if you believe there are unsafe or unhealthy conditions. OSHA will keep your name confidential. You have the right to have a representative contact OSHA on your behalf.
- Participate (or have your representative participate) in an OSHA inspection and speak in private to the inspector.
- File a complaint with OSHA within 30 days (by phone, online or by mail) if you have been retaliated against for using your rights.
- See any OSHA citations issued to your employer.
- Request copies of your medical records, tests that measure hazards in the workplace, and the workplace injury and illness log.

This poster is available free from OSHA.

Employers must:

- Provide employees a workplace free from recognized hazards. It is illegal to retaliate against an employee for using any of their rights under the law, including raising a health and safety concern with you or with OSHA, or reporting a work-related injury or illness.
- Comply with all applicable OSHA standards.
- Report to OSHA all work-related fatalities within 8 hours, and all inpatient hospitalizations, amputations and losses of an eye within 24 hours.
- Provide required training to all workers in a language and vocabulary they can understand.
- Prominently display this poster in the workplace.
- Post OSHA citations at or near the place of the alleged violations.

FREE ASSISTANCE to identify and correct hazards is available to small and medium-sized employers, without citation or penalty, through OSHA-supported consultation programs in every state.

Contact OSHA. We can help.

1-800-321-OSHA (6742) • TTY 1-877-889-5627 • www.osha.gov

OSHA 3165-04R 2015

APPENDIX K

OCCUPATIONAL INCIDENT REPORT FORM & PROTOCOL

APPENDIX J
INCIDENT REPORT
RMS 3

Stantec

HSSE event report – RMS3

Incidents involving injury, potential injury, or report of pain, soreness, or discomfort must be reported immediately (within one hour) to a supervisor. Supervisors will then immediately contact their HSSE manager/advisor to discuss incident severity and determine further notification. This form must be completed and **submitted within 24 hours** of any incident. Do not delay submission waiting for signatures. **Email to** hsse@stantec.com **or fax unsigned report to (780) 969-2030** and file locally in compliance with the corporate records retention policy and practices once all signatures have been obtained.

This document contains privileged and confidential information prepared at the request of Stantec's Legal Counsel. The contents of this report are restricted to HSSE, HR personnel, Risk Management Representatives, Project Manager and BC Leader, and Stantec's Insurer, Adjuster and Legal Counsel. Information collected will be used solely for the purpose of meeting the requirements of Stantec's HSSE and insurance programs, complying with applicable legislation, and will be used in accordance with any governing privacy legislation. The information collected will be maintained electronically and may be included in required reports.

SECTION 1: GENERAL INFORMATION					
Office location:				BC number:	
Location of incident:					
Incident date:		Incident Time:		Date Reported:	
Project name:				Project number:	
Client Name:					
Person in charge:				Person in Charge Phone:	

SECTION 2: INVOLVED STANTEC EMPLOYEE INFORMATION (if more than one identify extras in incident details below)			
Name:		Phone:	
Job position:		Group name:	
Time employee began work:		Job Experience (in years)	
Type of employment:	Full Time ☐ ; Visitor ☐ ; Contract ☐ ; Volunteer ☐ ; Seasonal ☐		
Supervisor:		Supervisor Phone:	

SECTION 3: INCIDENT DETAILS	
Type of Incident:	*incident types marked with an asterisk, please complete sections 1, 2 and 3 and sign below. **See StanNet for a list of** Incident Type Definitions

Incident Severity (0-4 Serious):		**Incident Likelihood: (1-4 Very Likely)**	
☐ ******Report Only*	☐ First Aid	☐ Motor Vehicle Incident	☐ 3rd Party Incident (i.e., Public)
☐ ******Hazard Identification*	☐ Medical Aid – No Lost Time	☐ Property Damage - Vehicle	☐ Spill or Release
☐ ******Near Miss*	☐ Restricted Work	☐ Property Damage - Other	☐ Utility Strike
☐ ******Safety Opportunity*	☐ Lost Time	☐ Security	☐ Fire/Explosion/Flood
☐ *Critical Risk?*	☐ Fatality	☐ Contractor Recordable Incident	☐ Stop Work Authority
☐ *High Potential Incident?*	☐ Violence or Harassment	☐ Non-compliance	☐ Work Refusal
Describe incident in detail: (include any issues related to people, equipment, materials, environment, and processes)			

Canada East (Atlantic) – Kyle Ferguson (902-240-3847); Canada East (ON) – Jared Memory (647-969-3709);
Canada East (Quebec) – Claudine Tremblay (514-668-4820); Canada Mountain – Shawna Robichaud (587-894-2635);
Canada Prairies – Yvonne Beattie (780-616-8909); International – Kev Metcalfe (780-231-2185); US Northeast – Fred Miller (610-235-7315);
US Central – Wes Cline (916 281-7459); US South - Keith Kuhlmann (740-816-6170); US West – Tony Wong (805-234-6227)

Immediate corrective actions taken:	
Submitted by (add signature):	

SECTION 4: MEDICAL INFORMATION

Name of first aid attendant:	Injury recorded in first aid log? Yes ☐ No ☐ N/A ☐
Description of first aid or medical treatment administered:	
Clinic/hospital sent to:	
Attending physician/paramedic (if known):	

Area of Injury – Please check all that apply:

☐ Head	☐ Teeth	☐ Upper back	Left	Right	Left	Right	Left	Right	Left	Right
☐ Face	☐ Neck	☐ Lower back	☐ Shoulder ☐		☐ Wrist ☐		☐ Hip ☐		☐ Ankle ☐
☐ Eye(s)	☐ Chest	☐ Abdomen	☐ Arm ☐		☐ Hand ☐		☐ Thigh ☐		☐ Foot ☐
☐ Ear(s)		☐ Pelvis	☐ Elbow ☐		☐ Finger(s) ☐		☐ Knee ☐		☐ Toe(s) ☐
☐ Other	Specify ______		☐ Forearm ☐				☐ Lower Leg ☐		

Has the injured employee had a previous similar injury or disability?	Yes ☐	No ☐

SECTION 5: PROPERTY OR VEHICLE DAMAGE: STANTEC

Ownership Details (choose one):	☐ Rented (attach rental agreement)	☐ Stantec Owned	☐ Personal (employee vehicle)
Year, Make, and Model of Vehicle:		Vehicle ID # (VIN)	
Nature of damage:		Estimated cost of damage:	$
Description of damaged property:			
Attending police officer (if known):		Badge #:	
Copy of police report received	Yes ☐ No ☐ If yes, file number:	(attach copy of police report)	

PROPERTY OR VEHICLE DAMAGE: 3RD PARTY

Name of owner and contact number:			
Year, Make, and Model of Vehicle:		License Plate Number:	
Insurer and Policy Number:			
Injured parties? Yes ☐ No ☐	If yes, describe Injuries:		
Diagram or photographs attached?	Yes ☐ No ☐		

WITNESS INFORMATION - #1

Name:		Phone Number:	
Witness statement provided?	Yes (attached) ☐	No ☐	

WITNESS INFORMATION - #2

Name:		Phone Number:	
Witness statement provided?	Yes (attached) ☐	No ☐	

Canada East (Atlantic) – Kyle Ferguson (902-240-3847); Canada East (ON) – Jared Memory (647-969-3709);
Canada East (Quebec) – Claudine Tremblay (514-668-4820); Canada Mountain – Shawna Robichaud (587-894-2635);
Canada Prairies – Yvonne Beattie (780-616-8909); International – Kev Metcalfe (780-231-2185); US Northeast – Fred Miller (610-235-7315);
US Central – Wes Cline (916 281-7459); US South - Keith Kuhlmann (740-816-6170); US West – Tony Wong (805-234-6227)

SECTION 6: SPILL OR RELEASE			
Substance:			
Quantity:		Employee(s) exposed via:	☐ Inhalation ☐ Contact ☐ Ingestion ☐ n/a
Off-site impacts observed or anticipated?	Yes ☐ No ☐ If yes, describe:		
Name of regulatory agencies contacted:			
Contact name, number, date and time of call:			

SECTION 7: ANALYSIS

DIRECT CAUSES

A. ACTIONS TO IMPROVE (check off as many as necessary)

- ☐ Operating equipment without authority
- ☐ Lack of warning
- ☐ Did not secure
- ☐ Operating at improper speed
- ☐ Disabling/removing safety devices
- ☐ Using defective/improper equipment
- ☐ Using equipment improperly
- ☐ Did not use personal protective equipment (PPE)
- ☐ Improper loading
- ☐ Improper placement
- ☐ Improper lifting or handling
- ☐ Improper position for a task
- ☐ Servicing equipment in operation
- ☐ Horseplay
- ☐ Procedure, policy, or practice, not followed
- ☐ Hazard or risk not identified
- ☐ Inattention
- ☐ Communication/coordination needs improvement
- ☐ Influence of alcohol or drugs suspected
- ☐ Did not check/monitor
- ☐ Did not react or correct

B. CONDITIONS TO IMPROVE (check off as many as necessary)

- ☐ Inadequate guards/barriers
- ☐ Improper/inadequate PPE
- ☐ Defective tools or equipment
- ☐ Congested work area
- ☐ Inadequate warning system
- ☐ Fire and explosion hazards
- ☐ Poor housekeeping; disorder
- ☐ Noise exposure
- ☐ Radiation exposure
- ☐ Temperature extremes
- ☐ Inadequate or excess illumination
- ☐ Inadequate ventilation
- ☐ Presence of harmful materials or environment
- ☐ Instructions/procedures need improvement
- ☐ Inadequate information/data
- ☐ Preparation/planning needs improvement
- ☐ Opportunity to improve support/assistance
- ☐ Road conditions
- ☐ Weather conditions
- ☐ Communications need improvement (hardware/software)

ROOT CAUSES

C. PERSONAL FACTORS (check off as many as necessary)

- ☐ Physical Capability
- ☐ Physical Stress
- ☐ Mental Stress
- ☐ Lack of Skill
- ☐ Lack of Knowledge
- ☐ Improper Motivation
- ☐ Abuse or Misuse
- ☐ Mental/Psychological Capability

D. JOB FACTORS (check off as many as necessary)

- ☐ Leadership or supervision
- ☐ Engineering
- ☐ Purchasing
- ☐ Maintenance (scheduled or preventative)
- ☐ Tools or equipment
- ☐ Work standards
- ☐ Excessive wear and tear
- ☐ Communications
- ☐ Other: Specify

SECTION 8: FOLLOW-UP				
Short-term:	**Corrective Action**	**Assigned To**	**Target Date**	**Completion Date**
Long-term:	**Corrective Action**	**Assigned To**	**Target Date**	**Completion Date**

REVIEW COMMENTS		
Involved Employee Comments:		
Signature: Job Title:	Print Name:	Date:
Supervisor/Project Manager:		
Signature: Job Title:	Print Name:	Date:
HSSE Representative (OSEC/JH&S Committee/HSSE Manager/HSSE Advisor):		
Signature: Job Title:	Print Name:	Date:
Management Review: (☐ not applicable)		
Signature: Job Title:	Print Name:	Date:
Additional Comments:		

Incident Reporting Protocol - US

IMMEDIATE ACTIONS

1. Keeping safety in mind, care for injured people (if applicable) and stabilize the scene.
2. For life threatening injuries, **immediately contact 911**. Accompany the injured employee to the medical facility whenever possible.
3. Call **WorkCare (24-hour service): 1-888-449-7787** for work-related symptoms or injuries, and speak to a medical professional for guidance and treatment options.
4. Make voice contact with your supervisor within 1 hour or less of the incident occurring. Leaving a voicemail does not count. If you cannot contact your supervisor, contact the HSSE Manager or HSSE Advisor for your region.
5. Supervisors must immediately contact their HSSE Manager or HSSE Advisor by phone to discuss incident severity and determine if further notifications (internal or external) are required.
6. When an employee is guided by WorkCare to obtain medical assistance, or the employee requests medical attention for a non-life threatening injury, and after alerting the supervisor; the employee must **immediately call Melissa Helton, Stantec's US WC Claims Coordinator at 513-720-3706** for assistance.
7. In most cases WorkCare will provide guidance about which clinic is available and provide directions. Some job sites already have prescribed clinics such as US Healthworks. Here is a link accessing additional clinic locations: Clinic Search link .
8. Additional notifications may be required based on the client requirements.

Contacts		Landline	Cell
HSSE Manager – US Central	Wes Cline	615-885-1144	916-281-7459
HSSE Manager – US South	Keith Kuhlmann	740-816-6170	740-816-6170
HSSE Manager – US Northeast	Fred Miller	610-235-7315	610-235-7315
HSSE Manager – US West	Tony Wong	805-250-2860	805-234-6227
HSSE Manager - International	Kev Metcalfe	780-917-7023	780-231-2185
Director HSSE Operations - US	Tami Renkoski	303-533-1964	720-530-7274
HSSE Senior Vice President	Jon Lessard	713-548-5700	281-513-5538
Your OSEC or HSSE Advisor	Master HSSE Representative Listing		

Region	WC Claims Coordinator	Landline	Cell
US (All Regions)	Melissa Helton	513-720-3706	513-720-3706

REPORTING

- **Within 24 hours of the incident, an RMS3 – Incident Report must be completed with as much information as possible and emailed to hsse@stantec.com.**
- Do not delay submitting the report to wait for signatures. Follow-up with signatures when possible.
- Complete the balance of the RMS3 within 5 business days, including signatures. Include information and corrective actions determined during the investigation/ Incident Causation Analysis (ICA), as coordinated by HSSE Advisor and/or HSSE Manager.
- Other protocols dictated by a client or project agreement, or internal practice may also need to be completed.

Document Owner HSSE
March 2018

Stantec

C .0-
235-7315);
US Central – Wes Cline (916 281-7459); US South - Keith Kuhlmann (740-816-6170); US West – Tony Wong (805-234-6227)

APPENDIX D

COMMENTS AND COMMENT RESPONES

APPENDIX D-1

A/T Comments on *P4's Ballard Mine 2018 Field Investigation Work Plan, Draft Rev 0, April 2018*

Transmitted to P4 on May 22, 2018

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
IDAHO OPERATIONS OFFICE
950 West Bannock, Suite 900
Boise, Idaho 83702

May 22, 2018

Molly R. Prickett
Environmental Engineer
Monsanto Company
Soda Springs Operations
1853 Highway 34
Soda Springs, Idaho 83276

Re: Comments on Ballard Mine, 2018 Field Investigation Work Plan, Draft Revision 0, April 2018.

Dear Ms. Prickett,

We have reviewed the above referenced deliverable, submitted pursuant to the Administrative Settlement Agreement and Order on Consent/Consent Order for Performance of Remedial Investigation and Feasibility Study at the Enoch, Henry, and Ballard Mine Sites in Southeastern Idaho (2009 AOC). This letter transmits comments on the draft work plan. Attachment 1 includes general and specific comments. Attachment 2 includes some additional specific comments and editorial comments.

Please contact me if you have any questions or concerns regarding this matter. I can be reached at 208-378-5763 or electronically at tomten.dave@epa.gov.

Sincerely,

//s//

Dave Tomten
Remedial Project Manager

Attachments
cc: Mike Rowe, IDEQ – Pocatello (electronic version only)
Jeremy Moore, US FWS – Chubbuck (electronic version only)
Kelly Wright, Shoshone Bannock Tribes (electronic version only)
Colleen O'Hara, BLM – Pocatello (electronic version only)
Sherri Stumbo, Forest Service – Pocatello (electronic version only)
Vance Drain, MWH (electronic version only)
Shannon Ansley, Shoshone Bannock Tribes (electronic version only)
Dennis Smith, CH2MHill (electronic version only)
Gary Billman, IDL – Pocatello (electronic version only)

Attachment 1 - Review Comments on: Ballard Mine, 2018 Field Investigation Work Plan, Draft Revision 0, April 2018.

General Comments:

The approach to conducting the subsurface explorations and characterizing the soils, rock, and groundwater at the mine site is reasonable and appears that this investigation will help meet the data needs to support the proposed Site Remedy.

It would be useful to include a summary of the approaches to be used to further refine and strengthen the lines of evidence for MNA (presented in the MNA Tech Memo), including approaches for data analysis, interpretation, and effectiveness monitoring. This information would provide context for evaluating adequacy of data including type, amount/frequency, and locations.

Specific Comments:

1) **Section 1.1.1, Page 1-3.** Objectives of the Borrow Source Investigation appear adequate.

2) **Section 1.1.2, Page 1-3, "Phase I – Plume Stability Evaluation", 2nd bullet.** We suggest adding a note regarding evaluation of existing COC trends, e.g. increasing/decreasing/stable. Otherwise, objective of MNA evaluation appear adequate.

3) **Section 1.1.2, Page 1-3, Last complete sentence.** We don't agree that the *MNA Memo* is sufficient to fully address Phase I MNA evaluation elements (e.g., determine plume status/stability). Comments on the *MNA Memo* provided previously suggested that more, strategically placed, monitor wells (MWs) were needed to definitively assess plume status/stability. The work plan indirectly recognizes this need by saying that new MWs will be used to confirm the Phase I MNA elements. We recommend that the authors directly state this as an important objective. Stating that the "Phase II MNA elements are the primary objective" of this effort (as is done on p. 1-4) implies that the Phase I elements are of low importance.

4) **Section 1.1.3, Page 1-4**. Objectives of the PRB Investigation appear adequate.

5) **Section 2.0, Table 2-1 referenced in Appendix A, #2 MNA Evaluation, Step 5.** Clarify this by saying that MWs will be installed in 12 alluvial and 1 Wells Formation boreholes (rather than just saying 13 total MWs)

6) **Section 3.1, Page 3-1, 2nd Paragraph.** In the test pit area on the SW side of BFR Road, suggesting adding text that states: depth to groundwater, or presence of groundwater/seeps into text pits that could potentially limit depth of borrow source, will also be evaluated (if these data are not already available).

7) **Section 3.1, Page 3-1, last Paragraph.** Text describes collecting two "discrete samples sampled from distinct layers" in the test pits. Please describe the purpose of discrete sampling. If this material is used for borrow, the entire stratum will be mixed during digging, loading, hauling, and placement. Sampling from discrete intervals does not appear necessary – please elaborate, e.g. will certain layers be segregated, etc.

8) **Section 3.1, Pages 3-2 and 3-3, Cover Material Investigation agronomic properties, and Table 5-1**.

(a) How will soluble Se, soluble Mg, and soluble Na be determined on soil samples? No extraction procedure is given under the Sample Prep heading in Table 5-1.

(b) The EPA 3050B extraction method (specified in Table 5-1) for Total Metals is actually described in the method as extracting what is potentially "environmentally available", not as total. Should make this clear (assume this will be used for analysis of As, Cd, Mo, U, B, Ca, P, K, although this is also not clear).

(c) Should specify which elements will be analyzed by ICP/MS (EPA 6020A) versus ICP (EPA 6010B).

(d) Conductivity is a water parameter – how will this be measured on soil samples? No extraction method is given in Table 5-1.

(e) Nitrate, Nitrite, Nitrate/nitrite, and ammonia should be described as "exchangeable", given the ASA extraction method listed in Table 5-1 (i.e., to distinguish these from total).

9) **Section 3.2, MNA Investigation and Drawing 3-2, Proposed MNA Alluvial locations.** A discussion of the rationale for selection of MW locations would be very helpful. Clarify why the number of proposed MWs, as sited, are adequate to fully evaluate MNA. For instance, it could be useful to have: (a) MWs positioned beyond the edge of each Se>MCL plume in the principal flow direction, to verify plume stability; and (b) two, or, even better, three, MWs located along the main axis of flow in each plume, from the source to the edge, to allow field-scale assessment of MNA.

10) **Section 3.2.1 [sic], Wells Formation Aquifer Investigation, Page 3-5.** Text notes that the borehole is anticipated to be 150 feet deep, and is not expected to reach groundwater. Consider drilling to 200 or 250 feet in order to reach groundwater to collect a groundwater sample from unimpacted Wells Fm.
Also, change Section Header to "3.2.2".

11) **Section 3.2.1, Page 3-4, Aquifer Solids Sampling, aquifer solids parameters, and Table 5-1**.

(a) Total metals. Like above, should specify which elements will be analyzed by ICP/MS (EPA 6020A) versus ICP (EPA 6010B). Semantics note: As is a semi-metal or metalloid, Se is a non-metal.

(b) Assume the Sequential Extraction Procedure (SEP) specified on p. 3-4 is the same as the Sequential Leaching parameter in Table 5-1. Suggest using consistent terminology.

(c) Sorptive batch testing. Since this is a custom method with no published standard method, the test procedure should be described. Similarly, a brief description of the Anoxic leaching method would be useful. (For example, will this simply use anoxic/reducing water as the extraction fluid, following the Tessier method? How will the anoxic/reducing water be produced? Anoxic [no DO] and reducing [low ORP] can be very different – what is the target?).

12) **Section 3.2.1, Page 3-4, Groundwater Sampling, aquifer solids parameters, and Table 5-1. (Note: similar comments apply to groundwater monitoring for Wells Formation samples.)**

(a) See 11(a) above.

(b) Major cations – will these be total or dissolved?

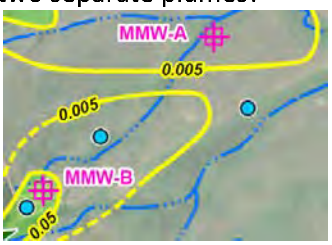
(c) What forms will be analyzed for Se speciation? Just SeIV and SeVI, or others as well?

13) **Section 3.3, Page 3-6.** The PRB investigation describes 6 PRBs that would be constructed on the east side of the site. Drawing 3-4 shows 3 PRB sites on the west side of the site (7, 8, and 9). When will PRBs on West Side be investigated and constructed? Add a discussion in the text.

14) **Section 3.3, Page 3-6, 2nd Paragraph, 3rd line.** Lists seep/spring MST**S**095. Should this be MST095? Revise.

Drawing 3-2:

1. Consider adding a well west of proposed well MMW-K for long-term monitoring downgradient of plume. (In the vicinity of the DP borings shown)
2. Show TP18-06 location for reference.
3. In the area between Proposed Alluvial Wells MMW-B and MMW-A, what data support showing two separate plumes?



Drawing 3-3:

1. Show the interpreted COC plume in the Wells Formation for reference, to show that Wells-A well is within plume, and Wells-B well is not.
2. Consider installing a monitoring well in the northern part of the COC plume in the Wells Formation for long-term monitoring of plume advance/stability. If the groundwater flow is to the north, as indicated on Drawing 3-2, then the northern extent of the plume may not be defined.

Drawing 3-5:

1. Explain why PRB-3 is shown as an odd configuration with a bend in the middle. Why not just construct in a straight line, more in line with the proposed exploration locations? Or, consider moving PRB location downstream to where valley pinches down and alluvium is more defined by bedrock constriction. Would this be a more suitable location?

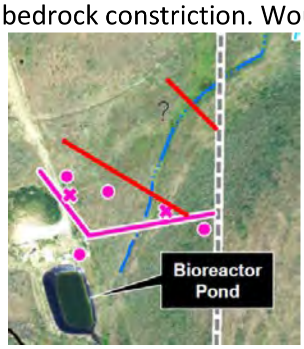


Table 3-1:

1. **Page 4 of 7, Alluvial MNA Investigation – Boreholes, TP18-06 Row.** In “Rationale” column, change “Drill a boring…” to “Excavate a test pit…”
2. **Page 5 of 7, Wells Formation MNA Investigation – Monitoring Well/Borehole, Wells–A Row.** In “Rationale” column, it states “collect up to 3 aquifer solids samples and a groundwater sample

from potentially downgradient and potentially impacted Wells Fm. well…". Based on Drawings 3-2 and 3-3, the "Wells–A" well would be placed in the heart of the impacted groundwater plume in the Wells Formation. Explain how this location is "potentially" impacted and potentially downgradient, or revise to state groundwater that is known to be impacted and not downgradient.

3. **Page 5 of 7, Wells Formation MNA Investigation – Monitoring Well/Borehole, Wells–B Row.** See previous comment about drilling this borehole deeper to intercept groundwater. This would appear to be a good location to collect unimpacted Wells Formation groundwater in addition to aquifer solids.
4. **Page 5 of 7 and 6 of 7, Phase I PRB East Side Investigations.** For all PRB locations, under "Rationale" column, suggest adding "hydraulic gradient" after "flow direction", as gradient is a necessary component of evaluating PRB sites.

Ballard Mine 2018 Field Investigation Work Plan (April 2018)						
COMMENTING A/T: IDEQ						
Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribes Comment	Did P4 Respond to Comment?
	General Comments					
	Specific Comments					
	1.3	1-5	Bullet 4		Change to "Section 5.0 – Presents the sample handling and analysis."	
	1.3	1-5	Bullet 6		Change to "Section 7.0 – Discusses the quality assurance and control requirements."	
	3.1	3-1	5 (last)	Sentence 4	How does a field engineer/geologist know which layers to sample if there are more than two "distinct layers?"	
	3.2.1	3-4	Bullet 6	Sentence 2	Insert "on" to read "Provides quantitative information on the capacity …"	
	3.3	3-7	Bullet 6		Change "use" to "used" to read "… and sulfate) – used in evaluation …"	
	4.7	4-5	5 (last)	Sentence 2	Based on Table 4-1 add ORP and ferrous iron to this list of field parameters for which meter performance will be calibrated.	
	5.0	5-1	1	3	Change "is" to "are" to read "… program are presented in Section 7.0." for subject-verb agreement.	
	5.3.1	5-2	Bullet 9		Change to "**GW** denotes that groundwater is sampled."	
	5.3.1	5-3	1		Insert "in July" to read "…collected from a monitor well in July would …"	
	5.3.3	5-4	1	Sentence 2	Insert commas to read "As applicable, this includes proper containerization, storing the sample in a refrigerated environment, and analyzing the sample within prescribed holding times."	
	7.2	7-2	1	3	Change the second "consistent with" to "and" to read "… consistent with agreed upon SOPs and the specified analytical method."	
	7.3.1.1	7-2	3	Sentence 2	Change to "Only equipment rinsate blanks from non-dedicated sampling equipment will be used for this project."	
	8.0	8-1	1	3	Insert "and" to read "…for hazard recognition and avoidance and will be provided to …"	
	Table 3-1	1/7	3	Column Rationale	Insert "of" in sentence 2 to read "… one composite sample composed of soils from each stratigraphic unit."	
	Table 5-1	1/4 & 3/4	Row Nitrate/Nitrite, N & Nitrite, N		The maximum holding time for analysis of these two parameters is 2 days. Will you be able to meet this deadline?	
	Table 5-1	3/4	Row Ferrous Iron		Isn't this being measured in the field so it is essentially a field parameter? Why include here?	
	Appendix A-1, Attachment J	1	Well Development Record	Development Measurements	Include pH in the list of Development Measurements?	
	Appendix C				Include a page indicating "Appendix C" for consistency.	
	Appendix C	i			Somewhere on this page include the title of the document "Health and Safety Plan."	
	Appendix A-1, SOP Borehole Drilling …	Attachment J				

APPENDIX D-2

P4 Responses to A/T Comments (dated May 22, 2018) on *P4's Ballard Mine 2018 Field Investigation Work Plan, Draft Rev 0, April 2018*

Transmitted to A/Ts on June 1, 2018

From: Drain, Vance <vance.drain@stantec.com>
Sent: Friday, June 01, 2018 8:31 AM
To: Tomten, Dave
Cc: MOLLY PRICKETT - P4 Monsanto (molly.prickett@monsanto.com); CHRIS R LEATHERMAN (chris.r.leatherman@monsanto.com); Leah Wolf-Martin (leah@wolfmartininc.com); Cary Foulk - Integrated-Geosolutions (cfoulk@integrated-geosolutions.com); Bollschweiler, Teresa
Subject: FW: Responses to A/T comments on Drf 2018 Ballard Investigation Work Plan and edited tables, drawings
Attachments: RTCs-DftBallard 2018 InvestWP_(05-30-18).docx; DftFnl Ballard 2018 Investigation WP text-Rev1(05-30-18).docx; DrftFnlTable 2-1 DQO-Rev1 (05-30-18).docx; DrftFnlTable 3-1SmplLoc_Ratnl Rev 1 (05-30-18).docx; DftFnlTables 4 and 5_Analytcl-Rev1(05-30-18).docx; Dwg 3-2_Prop MNA Alluvial Locs_30May2018.pdf; Dwg 3-5_Ballard_Prop PRB Characterization Locs_29May2018.pdf

Hi Dave,

Attached are our responses to your comments (the RTC file) on the *Draft 2018 Ballard Site Investigation Work Plan* that will support the MNA process and the design efforts at the Site. Also included in redline/strikeout are the main text and tables; in addition to the two Drawings that were edited based on the A/T comments.

Please forward this package to the A/T team. Once as a group, you are satisfied with our responses and edits, we will send the complete, revised document back to you as a pdf. (Also please note we have not made all the editorial comments in your Attachment 2 but will complete those edits, once there is general agreement to our approach/redlines in the attached documents)

Thank you Dave and have a great weekend.

Best Regards,

Vance Drain
Vice President/Fellow

MWH now part of Stantec

2890 E. Cottonwood Prkwy
Suite300
Salt Lake City, UT 84121
USA
vance.drain@stantec.com
www.stantec.com

Tel: +1 801 617 3250
Cel: +1 801 831 4059

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Attachment 1 - Review Comments on: Ballard Mine, 2018 Field Investigation Work Plan, Draft Revision 0, April 2018.

General Comments:

The approach to conducting the subsurface explorations and characterizing the soils, rock, and groundwater at the mine site is reasonable and appears that this investigation will help meet the data needs to support the proposed Site Remedy.

It would be useful to include a summary of the approaches to be used to further refine and strengthen the lines of evidence for MNA (presented in the MNA Tech Memo), including approaches for data analysis, interpretation, and effectiveness monitoring. This information would provide context for evaluating adequacy of data including type, amount/frequency, and locations.

Specific Comments:

1) **Section 1.1.1, Page 1-3.** Objectives of the Borrow Source Investigation appear adequate.

   P4 Response: *Thank you.*

2) **Section 1.1.2, Page 1-3, "Phase I – Plume Stability Evaluation", 2nd bullet.** We suggest adding a note regarding evaluation of existing COC trends, e.g. increasing/decreasing/stable. Otherwise, objective of MNA evaluation appear adequate.

   P4 Response: *The suggested language was added to the second bullet under Phase I – Plume Stability Evaluations.*

3) **Section 1.1.2, Page 1-3, Last complete sentence.** We don't agree that the *MNA Memo* is sufficient to fully address Phase I MNA evaluation elements (e.g., determine plume status/stability). Comments on the *MNA Memo* provided previously suggested that more, strategically placed, monitor wells (MWs) were needed to definitively assess plume status/stability. The work plan indirectly recognizes this need by saying that new MWs will be used to confirm the Phase I MNA elements. We recommend that the authors directly state this as an important objective. Stating that the "Phase II MNA elements are the primary objective" of this effort (as is done on p. 1-4) implies that the Phase I elements are of low importance.

   P4 Response: *The final paragraph in Section 1.1.2. now states:*

   "For the Phase I elements listed above, the existing data presented in the MNA Memo assists with the MNA evaluation, and with the addition of new Site monitoring wells proposed in this work plan, additional confidence will be warranted regarding the groundwater flow direction(s), contaminant concentration, variations, and distribution, and general groundwater chemistry. Phase II elements are an important part of this work plan and these new data, when combined with existing data, will augment and refine the current MNA conceptual model including plume(s) status and stability (i.e., a Phase I objective)."

4) **Section 1.1.3, Page 1-4**. Objectives of the PRB Investigation appear adequate.

   P4 Response: *Thank you.*

5) **Section 2.0, Table 2-1 referenced in Appendix A, #2 MNA Evaluation, Step 5.** Clarify this by saying that MWs will be installed in 12 alluvial and 1 Wells Formation boreholes (rather than just saying 13 total MWs)

P4 Response: *The second bullet has been edited to clarify the number of monitoring wells in each aquifer. Note that an additional alluvial monitoring well has been added in response to Comment 9. The bullet now reads:*

- *"Install monitor wells in 14 of the boreholes (13 alluvial and 1 Wells Formation monitoring well(s))"*

6) **Section 3.1, Page 3-1, 2nd Paragraph.** In the test pit area on the SW side of BFR Road, suggesting adding text that states: depth to groundwater, or presence of groundwater/seeps into text pits that could potentially limit depth of borrow source, will also be evaluated (if these data are not already available).

P4 Response: *The second paragraph is Section 3.1 now reads:*

"Additional data in this borrow area are needed to further characterize the vertical and horizontal extent, and geotechnical and agronomical properties of the alluvium for use as cover material. The planned borehole and excavation locations are shown on ***Drawing 3-1****. The results of this investigation will be utilized to define the borrow source area and, if required due to material properties, develop soil preparation and amendments so the cover material meets specifications. Please note that in the area south of the Blackfoot River road on Drawing 3-1 that will be investigated using test pits, the presence or absence of alluvial groundwater into the pits will be noted because groundwater could potentially limit the depth of a useable borrow source in that low-lying area."*

The text in red specifically addresses your concerns.

7) **Section 3.1, Page 3-1, last Paragraph.** Text describes collecting two "discrete samples sampled from distinct layers" in the test pits. Please describe the purpose of discrete sampling. If this material is used for borrow, the entire stratum will be mixed during digging, loading, hauling, and placement. Sampling from discrete intervals does not appear necessary – please elaborate, e.g. will certain layers be segregated, etc.

P4 Response: *Prior borrow area investigations at the Site indicate variability in the properties of the available alluvial materials. As a result, during this investigation, Monsanto proposes collection of discrete samples to determine the engineering characteristics of the individual alluvial layers in order to develop a borrow strategy that will optimize use of the most desirable earthen materials, while minimizing pre-processing of these materials (such as screening) to meet the final cover system specification. The combination of composite samples, discrete samples and mapping of alluvial stratigraphy via visual observations will allow Monsanto, as necessary, to develop a precise borrow plan. This plan will be prepared to minimize excavation of alluvial borrow material that is not suitable for the chosen cap design, and to maximize excavation of appropriate borrow materials and ultimately performance of the Ballard cover system.*

8) **Section 3.1, Pages 3-2 and 3-3, Cover Material Investigation agronomic properties, and Table 5-1**.

(a) How will soluble Se, soluble Mg, and soluble Na be determined on soil samples? No extraction procedure is given under the Sample Prep heading in Table 5-1.

P4 Response: *ACZ, the laboratory we have used in the past for these analyses, lists the extraction methods as Saturated Paste for soluble Mg and soluble Na, while the extraction method for soluble Se is hot water. A footnote has been added to Table 5-1 discussing the extraction methods for soluble Se, Mg, and Na.*

(b) The EPA 3050B extraction method (specified in Table 5-1) for Total Metals is actually described in the method as extracting what is potentially "environmentally available", not as total. Should make this clear (assume this will be used for analysis of As, Cd, Mo, U, B, Ca, P, K, although this is also not clear).

P4 Response: *A footnote (b) has been added to Table 5-1 to clarify that "EPA Method 3050B is an extraction method for As, Cd, Mo, U, B, Ca, P, and K. Extraction method for soluble Mg and Na is saturated paste and Se will be hot water."*

(c) Should specify which elements will be analyzed by ICP/MS (EPA 6020A) versus ICP (EPA 6010B).

P4 Response: *Specific methodology is not discussed in Section 3 – Sampling Plan and Rationale. This information is presented in Section 5 – Sample Handling and Analysis. The precise EPA method for each metal, metalloid, and non-metal to be analyzed during the planned soils investigations are specifically listed in Table 5-2. As, Cd, Mo, Se, and U will be analyzed by SW6020A and Ca, K, Mg, Na, B, P, Al, Fe, and Mn will be analyzed by SW6010B. No change is necessary in Table 5-2.*

(d) Conductivity is a water parameter – how will this be measured on soil samples? No extraction method is given in Table 5-1.

P4 Response: *Conductivity is measured on the fluid from the USDA No. 60 (2) extraction method. This method has been added to Table 5-1.*

(e) Nitrate, Nitrite, Nitrate/nitrite, and ammonia should be described as "exchangeable", given the ASA extraction method listed in Table 5-1 (i.e., to distinguish these from total).

P4 Response: *The extraction method for the nitrite and nitrate/nitrate has been revised to ASA 10-2.3.2 (Water Extraction), and therefore, the results are for the soluble form. Table 5-1 has been revised to reflect this. For ammonia the extraction method was correct, and the table has been revised to indicate "KCL Extractable".*

9) **Section 3.2, MNA Investigation and Drawing 3-2, Proposed MNA Alluvial locations.** A discussion of the rationale for selection of MW locations would be very helpful. Clarify why the number of proposed MWs, as sited, are adequate to fully evaluate MNA. For instance, it could be useful to have: (a) MWs positioned beyond the edge of each Se>MCL plume in the principal

flow direction, to verify plume stability; and (b) two, or, even better, three, MWs located along the main axis of flow in each plume, from the source to the edge, to allow field-scale assessment of MNA.

P4 Response: *Table 3-1 has the rationale for each of the 13 proposed new alluvial monitoring wells. In general, these new alluvial monitoring wells will be installed to complement the existing alluvial monitoring wells. These new wells have been positioned depending on the plume to monitor the medial, distal, or flanks of the existing plumes. Refer to Drawing 3-2 for the location of the existing alluvial monitoring wells (in blue) and the proposed monitoring wells (pink). For example, on the southwestern side of the Site proposed new alluvial monitoring wells MMW-J and MMW-D have been added to the largest alluvial plume to monitor the medial and distal positions within that plume and when combined with the existing monitoring wells (MW-15A, MBW011) will accomplish precisely what you are suggesting. Also, additional monitoring wells have been added downgradient of the southwestern plumes along the Blackfoot River (MMW-G, MMW-F, and MMW- E) to monitor off Site migration of these plumes and the possibility of natural attenuation from the existing natural wetlands adjacent to the Blackfoot River corridor.*

One additional alluvial monitoring well location is suggested and will be added downgradient from MMW032 on the northeastern side of Ballard to monitor the distal toe of that small Se plume (refer to Drawing 3-2) that was defined during the direct push investigation in 2009. The text, tables, and Drawing 3-2 have been updated to reflect the addition of the new well – MMW-M.

10) **Section 3.2.1 [sic], Wells Formation Aquifer Investigation, Page 3-5.** Text notes that the borehole is anticipated to be 150 feet deep, and is not expected to reach groundwater. Consider drilling to 200 or 250 feet in order to reach groundwater to collect a groundwater sample from unimpacted Wells Fm.
Also, change Section Header to “3.2.2”.

P4 Response: *The assumption with the location of this borehole (Wells-B in Figure 3-3) is that the key sand beds that occur in the upper portion of the Wells Formation will be encountered within 150 feet of the surface and will not be impacted, or at least minimally impacted, because they will be unsaturated. The configuration of the pit floor in this location favors runoff opposed to infiltration through the relatively flat lying sedimentary rock package (i.e., stratigraphy).*

The condition and depth to groundwater in that specific fault block is unknown because it has not been previously drilled/encountered. However, it is believed that the depth to groundwater in that location may be as much as 350 feet. Because of flowing sands in the Wells Formation that have been encountered below the groundwater table at the Ballard Site, the drilling procedure may be different for a simple boring versus a planned monitoring well installation (specific procedures will be finalized once a drilling contractor is selected). For a well installation, casing often needs to be advanced into the water bearing sand zone then extracted as the well is installed to prevent the flowing sands from compromising the proper installation the well. This procedure is difficult and costly, even more so the deeper the well, and it is not always successful. P4 will only attempt such a well for very specific data gap and feels a monitoring well at that location is currently unneeded. Should groundwater be encountered in the first 150 feet of *boring Wells-B, installation of a monitoring well will be attempted, but the well construction may not be ideal if flowing sands are encountered.*

The section header has been corrected.

11) **Section 3.2.1, Page 3-4, Aquifer Solids Sampling, aquifer solids parameters, and Table 5-1**.

(a) Total metals. Like above, should specify which elements will be analyzed by ICP/MS (EPA 6020A) versus ICP (EPA 6010B). Semantics note: As is a semi-metal or metalloid, Se is a non-metal.

P4 Response: *Specific methodology is not discussed in Section 3 – Sampling Plan and Rationale. This is presented in Section 5 – Sample Handling and Analysis. The precise EPA method for each metal, metalloid, and non-metal to be analyzed during the planned aquifer matrix investigation is specifically listed in Table 5-3. As, Cd, Mo, Se, and U will be analyzed by SW6020A and Ca, K, Mg, Na, B, P, Al, Fe, and Mn will be analyzed by SW6010B. No change is necessary in Table 5-3*

Regarding the comment on the generic use of "metals", the relevant bullet now reads to define the usage of metals in this context:

"Total metals", inclusive of metals, metalloids, and non-metals, (aluminum, arsenic, cadmium, iron, manganese, and selenium) – used to determine constituent concentrations in the aquifer matrix.'

(b) Assume the Sequential Extraction Procedure (SEP) specified on p. 3-4 is the same as the Sequential Leaching parameter in Table 5-1. Suggest using consistent terminology.

P4 Response: *The table has been edited to for consistent terminology.*

(c) Sorptive batch testing. Since this is a custom method with no published standard method, the test procedure should be described. Similarly, a brief description of the Anoxic leaching method would be useful. (For example, will this simply use anoxic/reducing water as the extraction fluid, following the Tessier method? How will the anoxic/reducing water be produced? Anoxic [no DO] and reducing [low ORP] can be very different – what is the target?).

P4 Response: *For the sorptive batching testing procedure an ASTM method will be used - <u>ASTM (American Society of Testing and Materials). 1987. "ASTM D4646-16, 24-hour Batch-Type Measurement of Contaminant Sorption by Soils and Sediments." In Annual Book of ASTM Standards, Water and Environmental Technology, Volume 11.04, pp. 163-167, Philadelphia, Pennsylvania. The procedure may be slightly modified at the time of the analyses to utilize multiple fluids with differing selenium concentrations and differing solid to liquid ratios after the physical character of the samples to be analyzed is observed.</u> The text and table have been updated to reflect this change.*

The objective of the anoxic leach testing is to reductively dissolve iron and manganese oxyhydroxides and hydroxides and specifically evaluate the net effect of a reduced fluid on the aquifer solids. This is being done to simulate the situation where reduced water from a PRB encounters these iron and manganese minerals, which have the ability to sorb COCs. Step 3 of the Tessier method is specifically designed to reductively dissolve these minerals and release their bound elements. Hydroxylamine hydrochloride-acetic acid is used as the reductant. Other more soluble elements will also be released, but the objective is to simulate net effect of what happens in the field when a reducing fluid contacts the aquifer solids, so the total release of the *more soluble COCs is also relevant. However, a DI rinse will also be conducted (i.e., without reductant reagent), to help define the relative contributions.*

The relevant bullet in the section has been revised to read:

"Anoxic leach test – this test (batch leach test with and without reductant reagent) will be used to simulate aquifer desorption potential under reduced conditions downgradient of the PRB (contaminants sorbed previously under oxic conditions may desorb under reduced conditions downstream of reducing PRBs). Specifically, Step 3 of the Tessier (1979) Sequential Extraction Procedure will be utilized to reductively dissolve iron and manganese oxyhydroxides and hydroxides that may bind COCs in the aquifer matrix. Hydroxylamine hydrochloride-acetic acid is used as the reductant in this procedure."

12) **Section 3.2.1, Page 3-4, Groundwater Sampling, aquifer solids parameters, and Table 5-1. (Note: similar comments apply to groundwater monitoring for Wells Formation samples.)**

(a) See 11(a) above.

P4 Response: *See response to 11(a) above, with the exception is that Table 5-4 is for the groundwater analytes*

(b) Major cations – will these be total or dissolved?

P4 Response: *This is defined in Table 5-4 and Section 5 of the work plan when specifics of the analytical program are presented.*

(c) What forms will be analyzed for Se speciation? Just SeIV and SeVI, or others as well?

P4 Response: *The procedure will provide results for total dissolved Se, SeIV, SeVI, and organic Se. This information has been parenthetically added to the bullet.*

13) **Section 3.3, Page 3-6.** The PRB investigation describes 6 PRBs that would be constructed on the east side of the site. Drawing 3-4 shows 3 PRB sites on the west side of the site (7, 8, and 9). When will PRBs on West Side be investigated and constructed? Add a discussion in the text.

P4 Response: *As described in the Ballard Site FS Memo #2 (MWH, 2017), remediation of the Site will be conducted in phases and the first phase of remediation will be conducted on the east side (Phase I), followed by the central core (Phase II), and end on the western flank (Phase III) of the Site. The PRB investigations proposed in this work plan are on the east side and correspond to the PRB locations that will be constructed during Phase I of remediation at the Site. Once the remedial design is completed for the Site and remediation begins, likely it will be 4 to 6 years depending on construction challenges before remediation of the west side of the Site and the PRBs that are in question will be investigated/remediated. It is hoped that during the incremental remediation process, the PRBs that have been installed during Phase I on the east side can improve the designs and construction methods of PRBs installed at later stages of the remedial action.*

Additional text has been added to Paragraphs 1 and 2 in Section 3.3 to explain/clarify the progression of remedial actions at the Site including future investigation and remediation using PRBs.

14) **Section 3.3, Page 3-6, 2nd Paragraph, 3rd line.** Lists seep/spring MST**S**095. Should this be MST095? Revise.

P4 Response: *The comment is correct. There was a typo that has been corrected.*

Drawing 3-2:

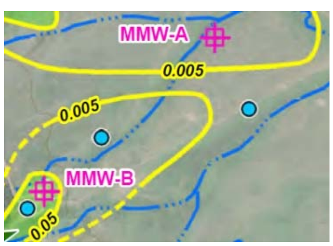
1. Consider adding a well west of proposed well MMW-K for long-term monitoring downgradient of plume. (In the vicinity of the DP borings shown)

   P4 Response: *The flow arrows on the figure are misleading/incorrect and will be revised. The area suggested for a well is not considered downgradient based on the direct-push investigation. Based on the apparent plume size and dimensions, groundwater flow is this area is relatively slow to almost stagnant in portions of the plume. What groundwater flow there is emerges from the dumps and is initially westward, but the surface drainage in this area flows northward. The plume configuration is consistent with the surface water drainage and suggests slow groundwater flow northward along the course of the drainage toward where monitoring well MMW-L is proposed. The area west of the plume is in fact a slight topographic rise and attempts to locate shallow groundwater in that area have been unsuccessful. Based on this, P4 suggests that the additional monitoring well is unneeded.*

2. Show TP18-06 location for reference.

   a. **P4 Response**: *The TP18-06 location has been added to the drawing.*

3. In the area between Proposed Alluvial Wells MMW-B and MMW-A, what data support showing two separate plumes?



   P4 Response: *The break between the two plumes is one professional's interpretation of the data based on the more detailed contouring that was presented in the Ballard RI Report (MWH, 2014, Drawing 4-27). The direct push borehole in front of the shorter southern plume had a selenium concentration of 0.0046 mg/L. This borehole appears to be almost directly downgradient of the plume, and based on this, there appears to be a gap between the plumes. It is recognized that given the data coverage it can easily be interpreted that the 0.005 mg/L plume contours have merged. Either interpretation is correct based on the available data. However, a change in this minor interpretation has no effect on the proposed investigation, any other aspect of the Site studies, or the future remedy components. P4 suggests that a revision to the drawing is not needed as either interpretation is correct*

Drawing 3-3:

1. Show the interpreted COC plume in the Wells Formation for reference, to show that Wells-A well is within plume, and Wells-B well is not.

   P4 Response: *In the highly fractured and faulted geologic terrain of the Site a potentiometric surface map is meaningless and may be misleading. Potentiometric difference between the fault blocks and individual tilted permeable beds may not mean flow between blocks or beds because of the structural offset of these features. Also note that the presumption is that the unsaturated Wells Formation at the Wells-B location will represent unimpacted Wells Formation as discussed in the response to Comment 10 (above).*

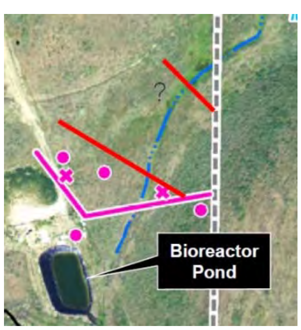
2. Consider installing a monitoring well in the northern part of the COC plume in the Wells Formation for long-term monitoring of plume advance/stability. If the groundwater flow is to the north, as indicated on Drawing 3-2, then the northern extent of the plume may not be defined.

   P4 Response: *Monitoring well MMW031 was installed expressly for defining conditions the northern edge of the impacted Wells Formation. However, MMW031 is <u>not</u> impacted and groundwater collected from this well contains background concentrations of COCs. Based on this finding, in order to better characterize the impacted groundwater flow northward in the Wells Formation, the upper sand beds in the formation near the contact with the Phosphoria Formation needs to be targeted. This is the purpose of suggested monitoring well Wells-A.*

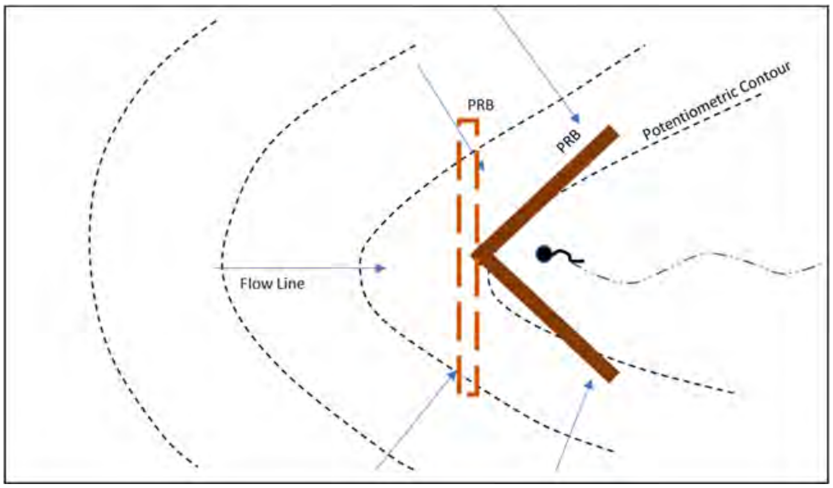
   Wells-A is in an area where the upper sand beds can be targeted and is in an area where there should not be significant infiltration of impacted water (refer to response to Comment 2 on Table 3-1). Therefore, any impact observed in groundwater collected from the proposed well is likely from upgradient source(s). Wells-A also will be installed in a partially backfilled area. As such, the well will help verify the northward gradient and define the limits of COCs in the upper Wells Formation. Based on the conceptual geochemical model of attenuation in backfilled mine pits, it is expected that it will provide data on attenuation in the Wells Formation.

Drawing 3-5:

1. Explain why PRB-3 is shown as an odd configuration with a bend in the middle. Why not just construct in a straight line, more in line with the proposed exploration locations? Or, consider moving PRB location downstream to where valley pinches down and alluvium is more defined by bedrock constriction. Would this be a more suitable location?

   P4 Response: *This is only a very conceptual design that may be more appropriate for the location given a steeper gradient and more topographic relief. The data collected as the result of* *the investigation proposed in this work plan, and other considerations, will result in the final design, which may or may not look like the concept on the drawing. However, as a way of further explanation, the flow toward a gaining seep and gaining stream is most often at oblique angles. That is, there is groundwater flow down the axis of the channel but most of the flow is from the sides. The inverted V shape can capture more flow toward the stream for the same width. The simple illustration below helps illustrate this concept and its geometrical considerations.*



The same flow lines can be captured further away from the stream using a longer linear PRB, but by staying closer to the stream the depth to groundwater is reduced, reducing depth of excavation needed. This is especially important at locations with steeper banks, like PRB-3. Some seeps at the Site occur in relatively flat areas, and the depth to groundwater is relatively uniform. At those locations the V-shaped design offers less of an advantage and a simple linear PRB is recommended.

Note that alignment and location of PRB-3 are a little off on the drawing. These will be corrected.

Table 3-1:

1. **Page 4 of 7, Alluvial MNA Investigation – Boreholes, TP18-06 Row.** In "Rationale" column, change "Drill a boring…" to "Excavate a test pit…"

   P4 Response: *The edit has been made.*

2. **Page 5 of 7, Wells Formation MNA Investigation – Monitoring Well/Borehole, Wells–A Row.** In "Rationale" column, it states "collect up to 3 aquifer solids samples and a groundwater sample from potentially downgradient and potentially impacted Wells Fm. well…". Based on Drawings 3-2 and 3-3, the "Wells–A" well would be placed in the heart of the impacted groundwater plume in the Wells Formation. Explain how this location is "potentially" impacted and potentially downgradient, or revise to state groundwater that is known to be impacted and not downgradient.

P4 Response: *The response to the comments on Drawing 3-3 above addresses this comment in part. To further explain, the bedding orientations and faulting dictate the flow of contaminants within the Wells Formation at the Site. The bulk of the contaminated groundwater associated with the West Ballard mine pit is in the northeast dipping upper sand beds of the Wells Formation. The strike of these beds is generally north-northwest. In addition, potentiometric measurements from monitoring wells installed within a single fault block (not separated by faulting) suggest northward flow that is consistent with the overall conceptual model of flow northward toward Henry Springs, a regional discharge location (discussed in the Ballard RI Report). Therefore, the proposed Wells-A location is likely downgradient of impacted monitoring wells MMW006, MMW020 and MMW021 in a contiguous geologic unit. Any other location to the west would be in other Wells Formation units where groundwater flow would have to reach the location by flowing perpendicular to bedding. The following text has been added after the second sentence of the first paragraph of Section 3.2.2 to address this comment on Table 3-1:*

> *"The strike of the Wells Formation bedding is generally north-northwest in the area of the West Ballard Mine Pit (MMP035), and potentiometric measurements from monitoring wells installed within a single fault block (not separated by faulting) suggest northward groundwater flow, which is consistent with the overall conceptual model of flow northward toward Henry Springs, a regional discharge location. Therefore, the proposed Wells-A location likely will be downgradient of impacted monitoring wells MMW006, MMW020 and MMW021 and will be in a "contiguous" geologic unit."*

Other minor edits to the paragraph have been made so that the existing and new text fit together and read properly.

3. **Page 5 of 7, Wells Formation MNA Investigation – Monitoring Well/Borehole, Wells–B Row.** See previous comment about drilling this borehole deeper to intercept groundwater. This would appear to be a good location to collect unimpacted Wells Formation groundwater in addition to aquifer solids.

   P4 Response: *Please see the response to Comment 10.*

4. **Page 5 of 7 and 6 of 7, Phase I PRB East Side Investigations.** For all PRB locations, under "Rationale" column, suggest adding "hydraulic gradient" after "flow direction", as gradient is a necessary component of evaluating PRB sites.

   P4 Response: *Correct; the suggested text has been added to Table 3-1.*

Ballard Mine 2018 Field Investigation Work Plan (April 2018)						
COMMENTING A/T: IDEQ						
Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribes Comment	Did P4 Respond to Comment?
	General Comments					
	Specific Comments					
	1.3	1-5	Bullet 4		Change to "Section 5.0 – Presents the sample handling and analysis."	Done
	1.3	1-5	Bullet 6		Change to "Section 7.0 – Discusses the quality assurance and control requirements."	Done
	3.1	3-1	5 (last)	Sentence 4	How does a field engineer/geologist know which layers to sample if there are more than two "distinct layers?"	Refer to P4's specific response #7 in RTC submitted 5-30-18
	3.2.1	3-4	Bullet 6	Sentence 2	Insert "on" to read "Provides quantitative information on the capacity …"	Done
	3.3	3-7	Bullet 6		Change "use" to "used" to read "… and sulfate) – used in evaluation …"	Done
	4.7	4-5	5 (last)	Sentence 2	Based on Table 4-1 add ORP and ferrous iron to this list of field parameters for which meter performance will be calibrated.	Added ferrous iron, ORP was already there
	5.0	5-1	1	3	Change "is" to "are" to read "… program are presented in Section 7.0." for subject-verb agreement.	Done
	5.3.1	5-2	Bullet 9		Change to "**GW** denotes that groundwater is sampled."	Done
	5.3.1	5-3	1		Insert "in July" to read "…collected from a monitor well in July would …"	Done
	5.3.3	5-4	1	Sentence 2	Insert commas to read "As applicable, this includes proper containerization, storing the sample in a refrigerated environment, and analyzing the sample within prescribed holding times."	Done
	7.2	7-2	1	3	Change the second "consistent with" to "and" to read "… consistent with agreed upon SOPs and the specified analytical method."	Done
	7.3.1.1	7-2	3	Sentence 2	Change to "Only equipment rinsate blanks from non-dedicated sampling equipment will be used for this project."	Done
	8.0	8-1	1	3	Insert "and" to read "…for hazard recognition and avoidance and will be provided to …"	Done
	Table 3-1	1/7	3	Column Rationale	Insert "of" in sentence 2 to read "… one composite sample composed of soils from each stratigraphic unit."	Done
	Table 5-1	1/4 & 3/4	Row Nitrate/Nitrite, N & Nitrite, N		The maximum holding time for analysis of these two parameters is 2 days. Will you be able to meet this deadline?	Yes. This is common analysis and labs that routinely conduct this analysis are prepared to meet the holding time.
	Table 5-1	3/4	Row Ferrous Iron		Isn't this being measured in the field so it is essentially a field parameter? Why include here?	Yes, ferrous iron is measured in the field using a Hach test kit with very specific procedures as discussed in Appendix B-2. The footnote for this procedure in Table 5-1 has been revised to point out that it is a field procedure.
	Appendix A-1, Attachment J	1	Well Development Record	Development Measurements	Include pH in the list of Development Measurements?	pH is included in the list of measured parameters during monitoring well development. Please refer to Appendix A, section 6.1.3.1 – Indicator parameters. No changes are necessary to the document.
	Appendix C				Include a page indicating "Appendix C" for consistency.	Done
	Appendix C	i			Somewhere on this page include the title of the document "Health and Safety Plan."	Done
	Appendix A-1, SOP Borehole Drilling	Attachment J				??

Ballard Mine 2018 Field Investigation Work Plan (April 2018)						
COMMENTING A/T: IDEQ						
Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribes Comment	Did P4 Respond to Comment?
	1.1.2	1-4	1	Sentence 2	Change to "… regarding the groundwater flow direction(s); contaminant concentration, variation, and distribution; and general groundwater chemistry.	Done
	3.2.2	3-5	1	Sentence 2	Change "This" to "These" to read "These upper Wells Formation sandstone beds …"	Done
	Table 2-1	1	Row 2 MNA Evaluation	Column Step 5	In the first bullet change "15" to "16" to read "Drill 16 boreholes (14 alluvial and 2 Wells Formation)	Done

APPENDIX D-3

A/T Additional Comments on *P4's Ballard Mine 2018 Field Investigation Work Plan, Final Rev 1, June 2018*

Transmitted to P4 on June 12, 2018

From:	Tomten, Dave
To:	Drain, Vance; PRICKETT, MOLLY [AG/1850]
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Subject:	Responses to A/T comments on Draft 2018 Ballard Investigation Work Plan
Date:	Tuesday, June 12, 2018 3:55:27 PM

Molly –

We have reviewed the responses to A/T comments on the above referenced deliverable. Responses to all comments were acceptable. Also, our reviewers noted a couple of minor editorial items, listed below, that need to be corrected. Please proceed with preparation and distribution of a final version for our approval and records.

If you have any questions, please give me a call.

1. Section 1.1.2, page 1-4, paragraph 1, sentence 2. Change to "… regarding the groundwater flow direction(s); contaminant concentration, variation, and distribution; and general groundwater chemistry. Change made.
2. Section 3.2.2, page 3-5, paragraph 1, line 2. Change "This" to "These" to read "These upper Wells Formation sandstone beds …" Change made.
3. Table 2-1, row 2. MNA Evaluation, column Step 5 – Develop the Analytic Approach. In the first bullet change "15" to "16" to read "Drill 16 boreholes (14 alluvial and 2 Wells Formation) Change made.

Dave

____

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